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The Engineer

VOL. CXC—No. 4933 28, ESSEX ST., STRAND, LONDON, W.C.2 AUGUST 11, 1950

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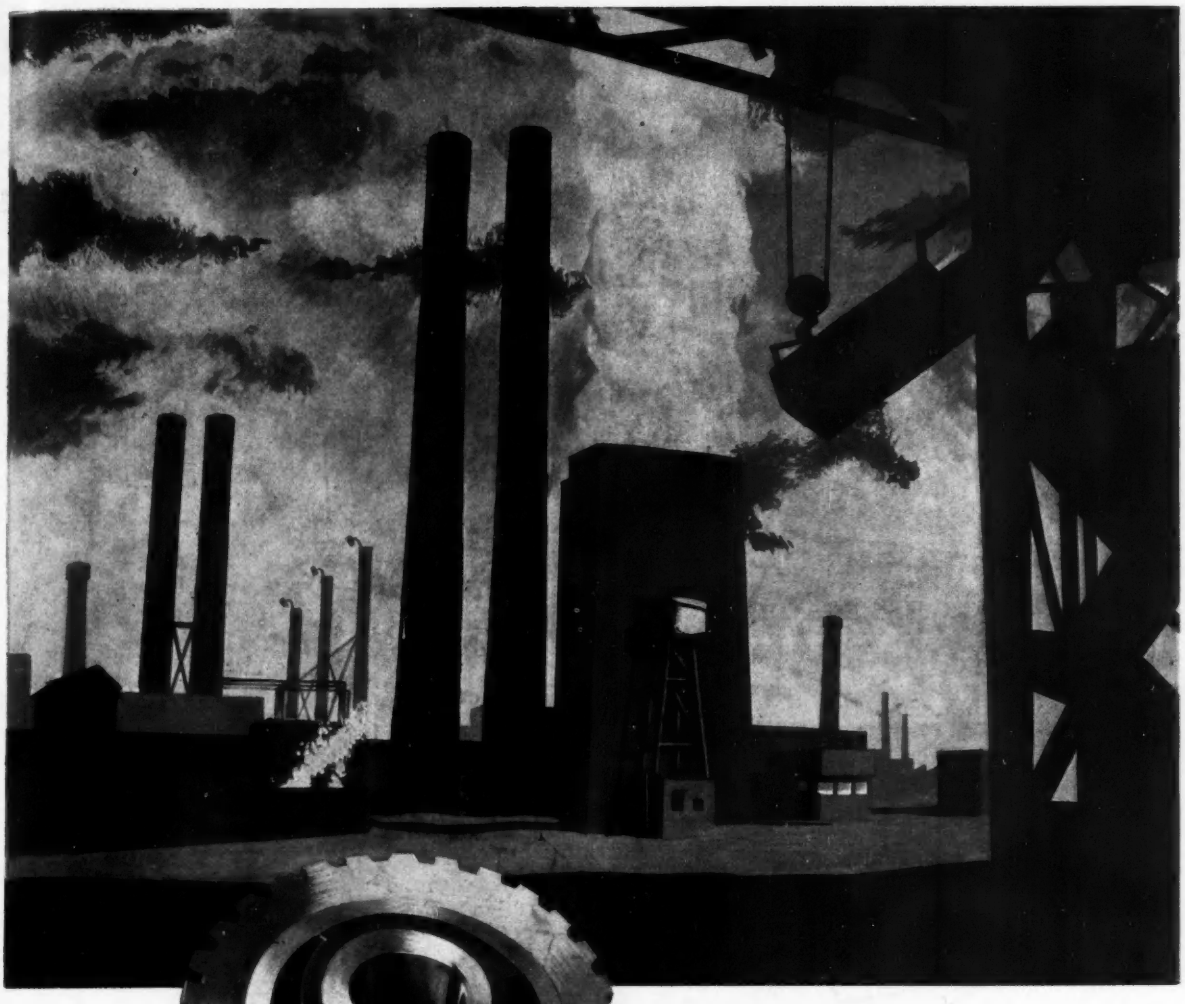

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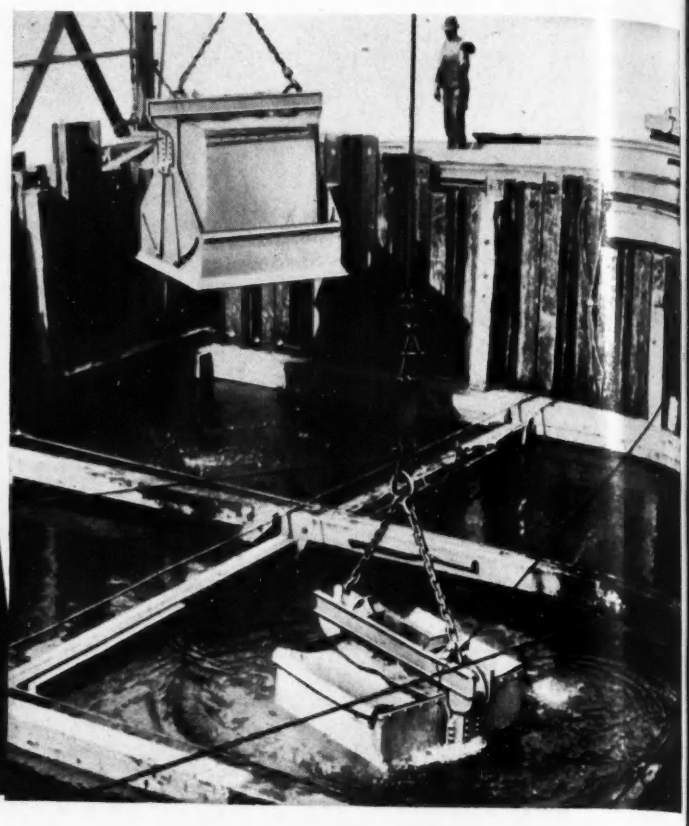

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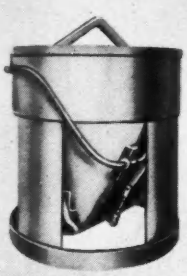

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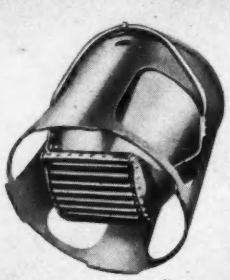

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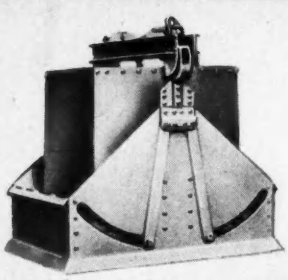

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British Iron and Steel Research Association

THE first report of the Joint Technical Panel N/P2 upon the Formulation of Anti-Corrosive Compositions for Ships' Bottoms and Underwater Service on Steel, has been published this week and gives the results of tests which were an extension of the earlier work of the Marine Corrosion Sub-Committee. The panel, set up in 1946, includes representatives of the Admiralty Corrosion Committee, the Association of Ships' Compositions' Manufacturers, the British Shipbuilding Research Association and the Protective Coatings Sub-Committee. For the investigation sixty-eight anti-corrosive compositions were prepared, which consisted of systematic variations of mixtures of basic lead sulphate, white lead, aluminium powder, Burntisland red and barytes, bound in phenol-formaldehyde/stand oil, coumarone/stand oil, and other media, including chlorinated rubber and dehydrated castor oil or tung oil, substituted for part of the stand oil. The protective properties of the compositions were tested by raft trials at Caernarvon and Emsworth and in a laboratory by a high-speed rotor apparatus, and the can stability of the compositions assessed under storage conditions. The specimens were 15in by 10in by ¼in thick mild steel plates of ship quality and the report discusses their preparation and illustrates by diagrams and tables the organisation of the research and the pigmentation of the compositions. The performance of the single anti-fouling paint used is stated to be satisfactory and the results are described and method of evaluation explained. Compositions in chlorinated rubber media have proved to be the best closely followed by phenolformaldehyde/stand oil/tung oil medium, and the report mentions that the effect of pigmentation was slight but that a limited increase in the aluminium content improved the protective properties. Composition No. 655 is recommended as the most promising of the new compositions. Recorded in the report is an account of subsidiary tests to formulate a method of preparing specimens which have a reproducible amount of mill scale on their surface. A number of photographs of selected specimens are reproduced and appendices give details of the method of manufacture of different media; the physical properties of the anti-corrosive compounds; evaluation of can-stability test results and a summary of service tests on the outer bottoms of ships.

The Association of Consulting Engineers

THE Committee of the Association of Consulting Engineers has recently issued its report covering the activities of the Association during the year ended April 30, 1950. The membership of the Association increased by thirty-five during the year and is now 303; about ninety requests for nominations for the services of consulting engineers were received by the Association during the course of the year, and as a result some 113 different firms were nominated. The report notes that there appears to be a tendency for nationalised industries to undertake their own consulting work, especially for smaller works, and in the future this may mean a decreased demand for the services of independent consultants. The Association is therefore taking such steps as it can to bring to the notice of the authorities concerned the necessity for employing consultants in this country, as it is only in this way, it is stated, that an adequate supply of consultants can be trained and available for work overseas. It may be recalled that in a Journal note of June 2nd last, on the occasion of the Association's annual dinner, we noted that the Association had taken steps to secure work in Canada, on the basis that the profession as a whole could advertise there. The report contains some further remarks on this scheme and states that it was considered that the best line of approach in the first instance would be with regard to sewerage and sewage disposal works. Colonel A. F. Lowe, M.C., M.I.C.E., was appointed the Association's representative and left for Canada at the end of April. Several committees of the Association were constituted during the year and a special committee, under the chairmanship of Mr. J. Duvivier, represented the views of the Association to the Joint Standing Committee of the Association, the Institution of Civil Engineers and the Federation of Civil Engineering Contractors, which reached final agreement last December on the revisions to the "General Conditions of Contract and Forms of Tender, Agreement and Bond." The Chairman of the Association for the year under review was Mr. T. A. L. Paton, M.I.C.E., a partner of the firm of Sir Alexander Gibb and Partners, and the Chairman for the present year is Mr. R. W. Mountain, M.I.C.E., M.I.E.E., a partner in the firm of Kennedy and Donkin.

Britain's Defence Programme

IN a memorandum handed to the American Ambassador last week the Government announced a new programme which would increase the defence expenditure of the United Kingdom to £3400 million over the next three years. This announcement followed a request by the United States Government for information concerning the nature and extent of the increased effort, both as regards Forces and military production, this country was willing and able to undertake. Before the aggression in Korea this country was spending £780 million a year on defence and an additional immediate programme of £100 million for arms and equipment had been put in hand. The programme put forward in the memorandum means that the Government is now prepared "in principle" to increase the total defence expenditure from nearly 8 per cent of the national income to 10 per cent. How far it would be possible to go towards this new and upper limit, it is stated, would depend on the amount of assistance forthcoming from the United States. To implement the full programme would entail very heavy costs in payment of necessary dollar and other imports, loss of exports and reduction of essential home investment. The burden would be so heavy that it would be impossible to carry out the full programme without substantial assistance from the United States in addition to the completion of the European Recovery Programme. It will entail real and substantial sacrifices by the British people, delay the recovery and postpone the improvement in their circumstances. Therefore, the memorandum states, the Government does not feel able to undertake consistently with the objectives indicated by the United States so full a diversion of productive resources to defence purposes unless it can offer financial assistance. While part of this assistance would be required to pay for materials, machine tools, &c., from the United States itself, it would be essential that the remainder should be dollars which could be used in any part of the world. Early deliveries of machine tools, raw materials and other items from United States sources would be essential to the execution of the programme.

American Bureau of Shipping

AT the half-yearly meeting of the board of managers of the American Bureau of Shipping, Mr. J. Lewis Luckenbach, the chairman, stated that 8554 vessels, of 36,416,246 gross tons, were classed with the American Bureau and that 25 per cent of them were laid up. Current construction amounted to 217 vessels, of 824,637 tons, bringing the grand total to 8771 vessels, of 37,240,883 tons, which included ships on the Great Lakes and river craft. Expansion of business abroad had caused a number of additional exclusive and non-exclusive surveyors to be stationed at foreign ports and he was pleased to disclose that Spain now recognised the American Bureau as an authority for the certification of load lines and for classification. The 1950 edition of the Bureau's "Rules for Building and Classing Steel Vessels," includes some modifications, relating to hull construction and materials, one being the method of determining design factors for obtaining deck beam scantlings and also certain changes in the machinery construction rules in order to agree with the latest codes and practices. The chairman's report mentioned that the technical staff were evolving new rules for tankers up to 700ft in length and that it was hoped to reach agreement upon electrical requirements with the United States Coast Guard. Referring to the 1948 revised steel specifications (which were designed to improve transition temperature and energy absorption qualities), Mr. Luckenbach said that the first large tanker built of this steel entered service in 1949 and no fractures had been reported. Other activities of the staff related to the manufacture of shaft forgings and a study of tailshaft failures, which has eliminated certain suspect factors and indicated lines for further investigation. Several occurrences of abnormal pitting of gear wheel teeth have been investigated and longitudinal vibration set up by propellers diagnosed as the cause and the installation of new propellers has proved an effective answer. Speaking of new construction, the chairman commented upon the falling off in the number of large vessels building and drew attention to the increase in lake and river craft to meet the expanding demands of inland waterborne freight.

Alkali Works Report for 1949

THE eighty-sixth annual report on Alkali Works by the chief inspectors has been issued this week. It states that the number of works registered under the Act in 1949 totalled 969, covering 1741 separate processes. These figures indicate a reduction of fourteen and twenty-five in the respective totals compared with 1948 mainly related to the by-products of the coal carbonisation industry, so continuing the trend of recent years. In England and Wales inspectors paid 3752 visits, including 378 to unregistered works and 200 concerning spoilbanks, involving 2198 quantitative analyses of gases escaping to the atmosphere. In Scotland visits to registered works numbered 217, to unregistered works 175, and 119 chemical tests were made of fumes emanating from the works. (Appendix I, which only refers to England and Wales, records the number of registered works and lists the processes under inspection in all six districts.) The report briefly reviews the state of the industry and appendices give production figures for a number of materials for both 1948 and 1949, so that comparisons can be made. The treatment of spoilbanks by such methods as water-spraying and levelling, is discussed and the danger of fires emphasised, together with methods of confining such fires. Unregistered processes are dealt with in the report and a number of the more interesting cases, covering electricity generating stations, gas, paper and bleaching works, are briefly reviewed. Similarly, the problems which have occurred in a number of registered works are commented upon and the report gives an account of a number of specific cases relating to works producing alkalis, cement, sulphuric, nitric and muriatic acids, tar and zinc, to name just a few. The report discloses that research is in hand to determine the effect at ground level of discharges of sulphur dioxide from high chimneys and to evolve more practicable methods of elimination than those at present in use.

Productivity in British Industry*

No. IX—MECHANICAL HANDLING—Part I

By F. GARNER†, M.I.Mech.E., and A. SIDDALL‡, M.I.Mech.E.

THIS article outlines the aims and uses of mechanical handling as understood and applied in the seventeen factories of an organisation employing a total of 34,000 people in the manufacture of light engineering products. Some of the results obtained in raising productivity by mechanical handling are described.

A wide variety of motor vehicle and aircraft equipment is made in the different factories. Outputs vary from 20,000 per week of each for some products, to as low as three or four per week of each for other products. The largest factory has a payroll of 7000 and the smallest 100. With such diversity of factory size and product quantities there is scope, within the field of light engineering, for practically all types of mechanical handling.

The illustrations are representative of the mechanical handling equipment in use at the various factories of the organisation. Most of the examples are suitable, in principle, for general application in reducing, or simplifying, work movement. Many similar items of equipment are in use in British industry. Illustrations are largely confined to mechanisation of movement outside the actual production operation and a few comparative examples have been included, showing progress over the years. The use of hopper-feeds, dial and magazine feeds, and transfer machines, &c., have been regarded as a separate subject, outside the scope of the present article.

In the post-war years, approximately £4 million has been spent on new machine tools, mainly for raising productivity. A similar sum has been spent on new shop lay-outs, mechanical handling equipment and new tools and processes, again chiefly with the object of increasing productivity as distinct from increasing capacity by additional facilities. Output is approximately twice the volume of pre-war. This increase has been achieved by some additions to factory capacity and by additional labour but mainly by higher productivity. Increases in productivity have been brought about by improvements in product designs and manufacturing methods. Under the heading of manufacturing methods, improved mechanical handling has done much to raise the productivity of both direct and indirect labour, and has at the same time removed laborious, and in certain cases unpleasant, manual work movement. In some factories with large volume and limited variety, productivity is approximately 25 per cent higher with full mechanisation of work-handling than it would be by manual methods, and in a few of the largest factories, the difference is nearly twice this figure. As volume falls and variety rises, the scope for raising productivity and reducing costs by mechanisation of work movement is often lessened, so that, in an unfavourable case, the gain may be as low as 5 per cent.

Productivity, Quality and Cost

It has been found unwise to concentrate on increasing productivity without regard to product quality and cost. Unless all three factors are watched together, there is the danger that increased productivity may be obtained at the expense of product quality, and costs may rise, owing to internal productivity being raised beyond the economic limit, based on current engineering knowledge and present wage rates, plant and equipment costs. By studying these three items of quality, productivity and cost at the same time, and establishing initial objectives for each, it has been possible to obtain the greatest improvements in product quality and the greatest reductions in product costs in cases where there have been the greatest increases in productivity.

Mechanical handling is closely concerned with product quality and cost as well as productivity. For example, an elaborate conveyor system, costing some thousands of pounds and working to low capacity, could actually increase costs, although productivity, measured within the factory, improved. An example of mechanical handling helping to raise product quality is in the large-scale testing of sub-assemblies and finished articles over a fixed time; the individual testing of, say, 300 small motors per hour, each for a period of twenty minutes, would be a complex and uncertain procedure by manual means, whereas, with a mechanical conveyor, the timing of each unit is always complete, and work is reduced to loading and unloading the test fixtures when they arrive at the loading station. Such an arrangement will be illustrated in Fig. 18. A wrong application of mechanical handling in place of manual work movement could result in greater damage to products, whereas a correct application should, and often does, reduce damage.

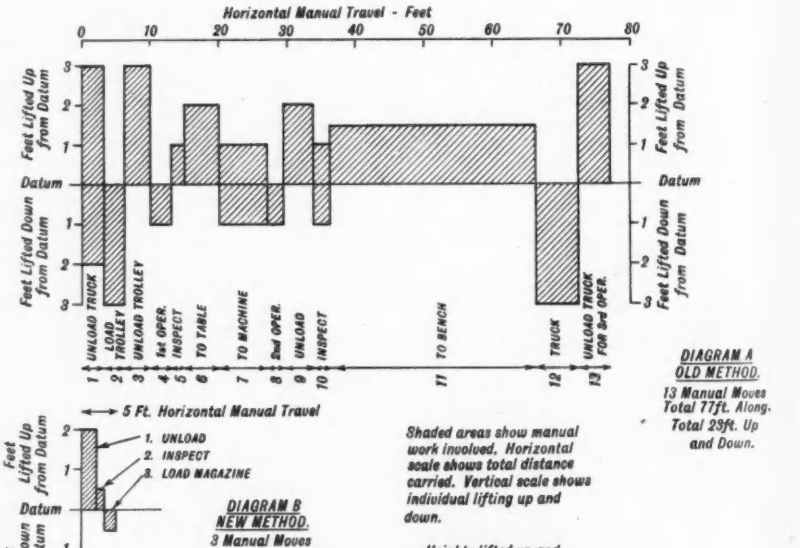
Scope of Mechanical Handling

In some instances, mechanical handling has made the greatest single contribution to increased productivity, other factors being rationalisation of product design, greater volume, new machine tools, new shop lay-outs and improved tools and processes. Whereas these other items affect mainly direct producers, the advantages of mechanical handling can be applied to most productive, and to some non-productive, labour. As all grades of employees must be included in productivity calculations, this means that a moderate return on mechanical handling improvements over a wide range of labour can yield a greater overall increase in productivity than a more spectacular change in, say, a particular process which can be applied on a limited scale to direct labour only.

The return on given expenditure by way of reduced costs has been greater on mechanical handling than on most machinery improvements. New machinery is expensive and cutting times in light engineering are already so low in relation to the floor-to-floor times that, in many instances, only by improved work manipulation, often involving mechanical handling, can worthwhile economies be made.

Mechanical handling has been applied with equal success to the receipt of raw materials, work in process, distribution of packing boxes, dispatch of finished products, and the disposal and baling of swarf. The problem of correct raw material handling starts with the supplier, so that the material is received in the manner in which it can best be handled at the user's receiving deck, and in the stores and factory. In the same way, mechanical handling for the dispatch of finished products has to be worked out in co-operation with the customer so that his unloading and storage arrangements will suit the pallets and other packing arrangements that are used.

The best results are invariably obtained from the most simple mechanical handling devices. For example, one of the factories



Diagrams showing manual movement of work by old and new methods.

FIG. 1

* No. I, "An Introductory Survey," by B. White, appeared February 17th; No. II, "The Threshold of Productivity," by F. A. Martin, March 3rd; No. III, "High Productivity and Production Costs," by Sir Claude Gibb and Gordon M. Baker, March 17th; No. IV, "Standardisation in the Aircraft Industry," by E. C. Bowyer, March 31st; No. V, "Restrictive Practices," by Arthur Woodburn, April 21st; No. VI, "Research for Productivity," by Dr. D. F. Galloway, May 19th; No. VII, "Consequences of Simplification," by W. D. King and H. Sherburn, June 30th; No. VIII, "Works Extensions," by C. K. F. Hague, July 28th and August 4th.

† Director, Joseph Lucas, Ltd.

‡ Director, Chief Production Engineer, Joseph Lucas (Electrical), Ltd.

dealing with large quantities of the same basic article in wide variety was equipped, before the last war, with seventy monorail conveyors, requiring electric motors of 90 h.p. installed capacity to drive them. The original plan was to make the conveyors act as transport and mobile storage mediums, so as to keep work off the floor of the shop and, at the same time, facilitate the cyclical manufacture of this wide variety. Experience has shown that such mechanical handling arrangements are too complex to be mastered and worked effectively by factory supervision. Further simplification and standardisation of product design in this particular factory has recently taken place, with the result that a new shop lay-out is now being completed with a small number of short, straight, simple and effective monorail conveyors, the rest of the work movement being by chutes and hoppers. The modified lay-out operates with greater order and certainty, was cheaper to install, is less costly to maintain, gives economy in electric power, requires less work in process, reduces damage to components and can be readily and effectively operated by the factory supervision, with improvement in productivity over the older, more complex, scheme.

It is frequently found that materials are handled manually several times, whereas close study might show that the picking up and dropping down operations could be substantially reduced and that, for essential work movement, simple and cheap mechanical handling facilities could often be provided to eliminate or reduce manual work movement. Fig. 1 shows diagrammatically the extent to which manual work movement was reduced on a particular process following detailed study. The first diagram, *A*, shows the manual handling of metal before study; the material was carried manually on thirteen different occasions through a horizontal distance totalling 77ft. In addition to the horizontal travel, the thirteen movements were responsible for a combined vertical lift and drop totalling 23ft. The second diagram, *B*, shows what was proposed after study. Manual carrying is reduced to picking up twice and dropping down once, the horizontal manual travel is reduced to 5ft (93 per cent reduction) and the vertical lift and drop is reduced to a total of 3ft (a reduction of 87 per cent). In reducing manual handling from thirteen to three occasions, five were entirely eliminated by new procedure and the remaining five were mechanised. In this particular case, the elimination of unnecessary handling saved more than was possible with the introduction of mechanical facilities.

Materials, varying widely in volume and weight, are being handed mechanically with equal success. The previous example of reduced work movement is also a good case of the worthwhile application of mechanical handling of heavy work, the weekly weight involved totalling approximately 300 tons. At the light end of the scale, small needle bearings, weighing but a few pounds for the whole week's production, are mechanically fed into a sub-assembly instead of being handled manually, resulting in a 500 per cent increase in productivity for this particular operation.

Mechanical Handling and the Future

As there can be no finality to improved product quality, increased productivity and reduced costs through technical advancements, progress in all fields, including mechanical handling, continues. Separate specialist teams work on each major product to improve quality, increase productivity and reduce costs. Initial objectives under these three headings have been prepared for each team, further work programmes have been established for the next few years, and it is clear that continuing improvement in mechanical handling will remain vital to improved quality and reduced cost, as well as to increased productivity.

Fundamental Principles of Mechanical Handling

The company's mechanical handling engineers are guided in their work by the following fundamental principles, which are applicable to mechanical handling in a wide range of light engineering industries.

(1) Work-handling is most effectively executed when the need is completely eliminated.

(2) Mechanical handling equipment must provide the utmost help in reducing the risk of accidents, improving general working conditions for operators, reducing damage to products, increasing productivity and reducing costs.

(3) Where mechanised work-handling is necessary, the first stage is to establish the correct relative positions of all factory buildings on one site, and the best locations of all plant, equipment, stores and receiving and dispatch decks, so as to ensure smooth work flow.

(4) Simplicity of lay-out and operation are important objectives. Providing it is effective, simple equipment provides better working conditions for labour at less expense than elaborate work-handling equipment.

(5) Arrangements must make possible a minimum volume of work in process consistent with high productivity. Accumulations on the floor of the shop, either loose or in boxes, must be avoided.

(6) Selection of the correct type of handling equipment to meet the particular need is vital. Misapplication is the root cause of most failures.

(7) Work should be moved in such a manner that it passes progressively from stage to stage, the ideal being a smooth, straight line flow from raw material delivery to dispatch of the finished product.

(8) Work should always be available for the operative to commence an operation without waiting; similarly, the operative should be able to place finished work aside without having to wait for the work moving equipment to arrive at the correct position for dispatch.

(9) Work should be delivered to the hand of the operative in the best position for commencing the operation. In the same way equipment should be such that the operative can place aside the work after completion of operation with a minimum of effort.

(10) Raw materials, components, assemblies, swarf and packing materials should travel the least possible distances.

(11) Elaborate overhead work movement schemes should only be installed if simple floor schemes are too extravagant in floor utilisation or have other serious disadvantages.

(12) The movement of waste products of a production operation cannot be ignored. In many production units, for example auto-screw machine shops or diecasting units, as much weight of material is produced in the form of swarf or flash as goes into the components produced, and requires as much study for economical movement.

Benefits of Correct Work Movement

Managers in charge of mechanical handling plant are expected to operate such equipment in a manner that makes possible the following benefits in the largest measure.

(1) Reduced accident risks, reduced risks to health and the best possible working conditions generally.

(2) Improved quality, increased productivity and reduced costs.

On quality, productivity and cost this means:—

(3) Raw materials, components and assembled products must be so dealt with on mechanical handling equipment that damage and deterioration are avoided. Random stacking and accumulation of work invariably lead to unnecessary damage and should not be tolerated.

(4) The improved general appearance of a factory, where work movement is good, helps to improve and maintain product quality. Inspection is facilitated because the identification of the stage of manufacture by geographical position of the product renders control easy and systematical. The hazards and problems besetting the quality engineer when control of work movement is not rigorous and clearly defined are well known.

(5) Operatives must be fed with the right amount of work so that the best possible productivity from given facilities can be obtained. Failure to supply operatives with work in the correct manner at the required rate is probably one of the largest single reasons for actual productivity being lower than attainable. The more effective the actual technique of manufacture, and the shorter the cycle time of the operations, so the relative importance of correct work-feeding increases.

(6) The volume of work in process must remain at the practical minimum. As far as possible, components must be produced and fed to assembly lines as required for building, as distinct from picking up and dropping down and letting lie after each operation.

(7) When mechanical handling is made to operate effectively, indirect labour is at a minimum. The higher the level of manufacturing technique, the greater the ratio between indirect and direct labour becomes, unless the efficiency of work movement keeps pace with method improvement. Analysis of the amount of indirect labour used in work-handling sometimes shows startling results.

Planning for Mechanical Handling

Materials handling should be a basic factor in the design and lay-out of any new factory, in the location of process plant and in the relative positions allocated to every piece of equipment. Unfortunately the horse is often made to follow the cart by installing a materials handling system to cope with an illogical arrangement of loading and dispatch decks, and plant distribution. In some cases, the very nature of existing buildings and services makes a perfect system impossible, but this does not mean that nothing can be done. In such cases, complete reorganisation of lay-out and services within existing factory buildings will often be possible, and well worth while, and, whilst not producing the ideal, is infinitely preferable to patching up what is inherently wrong.

The straight line system of work flow must be the constant objective. The perfect application is found in the factory where material enters at one end and proceeds by the shortest route through the various production processes to assembly and dispatch.

There are five stages in planning the installation of materials handling equipment. Stage one is basic—planning must start at the bar mill, the strip mill, the iron foundry,

or wherever the source of the raw material.

There are several decisions to be made at stage one—(i) Is the material in the ideal form for mechanical movement when received (ii) Are the bars the correct length—the coils of strip the right diameter—are small castings to be received in sacks or stillages or palleted ?

Typical application of the well-known power-driven fork trucks handling small but heavy articles in bulk. Such methods are generally several times more productive than manual handling with boxes and bags. To facilitate safe stacking of the pallet containers, so as to obtain good stores space utilisation, feet have conical recesses to fit corresponding projections at the top of the containers. These containers hold castings direct from the suppliers, and components are picked up for the first time when the container, arranged with a tipping device, is alongside the initial operation in the company's works.

FIG. 2

Power-driven fork truck used for transporting and stacking tray packings carrying 108 machines in place of boxes previously used for housing three machines. The packing is arranged in trays *A* which key *B* into each other and are held together by steel banding *C*. The new method is safer in stacking, increases productivity, reduces costs, uses less timber, and the space required per machine is reduced 45 per cent. Machines are "pack loaded" at the last operation in the company's factory and unloaded at the point of assembly by the user.

FIG. 3

Then follow the first problems of mechanical handling in many factories. What type of road transport vehicle will give the best off-loading with fork truck or overhead crane ? How is the material to be stored with maximum floor space utilisation and yet be readily transportable to the first production operation ? The solutions to these problems may mean new receiving decks, new vehicle bodies and new material holders.

Stage two is the passage of work through forming operations, where decisions have to be made on the selection of equipment for moving material from operation to operation. At this juncture careful planning by plant lay-out and process planning engineers is of first importance. The idea that the tool designer and process planner can regard material movement as of secondary importance is a thing of the past.

Processes must be planned for work to flow, and only then does the lay-out engineer make his decision on chutes, roller tracks, rails, monorails, belts, &c. These decisions are vital and, once made, cannot be rescinded without incurring great expense and waste. "Cut and try" cannot be accepted as a mechanical handling engineer's motto.

Stage three is movement to sub-assembly and main assembly lines, which can be a minor or major stage, depending entirely on the type of product and the general geography of the plant. The ideal of process lines converging on the assembly line cannot always be met and, in such cases, careful thought will be required on the types of equipment required to move the material to the correct station of the assembly line.

Stage four, the assembly and test stage, has probably passed through more phases of development during the last ten years than any other. In light engineering the idea of the wide conveyor belt as a maid of all work for any and every job is now almost extinct. The narrow belt, the roundabout and the travelling fixture type of conveyor have proved their worth in conjunction with monorail and overhead material feeds of various kinds. The wide belt still has, of course, limited applications.

Stage five is packing and dispatch, and that worthy team, the pallet and the fork truck, are well to the fore, with the spiral chute for the multi-storey building.

Lightweight battery-operated fork truck particularly suitable for use in multiple storey buildings with restricted floor loadings and lift capacities. Truck is delivering strip to power press from nearby slitting section. The main success of the scheme in reducing unnecessary handling is based on a special work holder *A* shown resting on a fixed stand *B* so that strip is at the correct operating height for feeding into the power press at the back of the stand. It will be seen that the holder is arranged with two longitudinal flanges *C* at the base to permit of nesting to form mobile stores racks. By using the holder and the truck, manual handling of strip is reduced from six occasions to one, as strip is dropped into position directly below the slitting machine and only requires picking up manually to feed into the press.

FIG. 4

Types of Mechanical Handling Equipment and Applications

Mechanical handling equipment can be grouped broadly as follows :—

Group 1.—Mobile : internal transport vehicles, trucks, tiering machines, tractors, trailers.

Group 2.—Fixed and semi-fixed : chutes, lifts and hoists, conveyor systems, pneumatic systems, cranes.

Group 3.—Material and work carriers: racks, shelves, containers, pallets.

Group 1.—*Mobile : Internal Transport Vehicles.*—The development of trucks and tiering machines has made great strides during the past few years. The variety and adaptations of the fork truck are being extended to the stage when a suitable form of machine is available for almost every task. The interdependence of the fork truck and the pallet, skid or pallet container is not yet fully realised and the development of pallets for various materials and components is still in its infancy. The following are some of the types of equipment in this category.

(*a*) Industrial hand trucks (manual operation).—Box, pallet lift, platform, dolly, gear-type, scale, reel, carboy, barrel, tool-wagon and tipping.

(*b*) Industrial power trucks (non-lifting).—High platform and low platform.

(*c*) Industrial power trucks (lifting).—High lift platform and low lift platform, fork, non-tilting, tilting, telescopic, ram, outclamping, crane, bar stock, and special attachments.

(*d*) Tiering machines.—Portable, fixed-frame (two and four-post manual and two and four-post power), revolving base, port-

able telescopic frame (two and four-post manual and two and four-post power), and suspended.

(e) Tractors and trailers.—Industrial tractors—three-wheel—four-wheel, pusher type, trailer train, industrial trailers, four-wheel steer, five-wheel steer, castor steer, side-dump and end dump.

The problems in the use of industrial mobile equipment are legion. The relations between vehicle width and aisle width, building and door heights relative to material stacking heights, and the overriding consideration of the cost of warehouse space are all important. Frequently, efficient transport requires building reconstruction, which is both necessary and economically justifiable. Unit loads, palletising and tiering of material are not always sufficiently understood and practised. Aisle widths must be sufficient for the effective use of trucks, and floors must be flat, smooth and sufficiently strong to carry the loads imposed. Doors opened by truck fenders should be reinforced by rubber or steel spring buffers to withstand the shocks imposed. Automatic door opening is often worthwhile.

Truck design, particularly of the high-lift type, presents the designer with very real problems; a narrow wheel gauge and very short turning radius, combined with precision control in load manœuvring and good visibility and, at the same time, good maintenance characteristics, are not easy to obtain. The industrial truck is one of the most abused pieces of equipment in the factory and, consequently, breakdowns are far too frequent. Preventative maintenance and attention to maintenance features in the basic design of trucks are items requiring attention. Figs. 2, 3 and 4 show examples of fork trucks in action.

(To be continued)

Some American Locomotives and their Running

No. I

By W. A. TUPLIN, D.Sc., M.I.Mech.E.

So much has been published in Britain about American railroads and locomotives that the possibility of learning much more about them by actual observation may seem to be remote, but in actual fact the writer found during a recent visit to America that there were many points that seemed worthy of setting on record in an English journal.

The first matter of importance is that of relative size. Although the rail gauge is the standard 4ft 8½in, many American locomotives have a height of 15ft 6in, as against 13ft 4in in England and a width of 10ft, as against 9ft. These figures do not represent the American limits; for example, the Pennsylvania "JI" and "JIA" class 2-10-4s and "Q2" class 4-4-6-4s are 16ft 5in high and 11ft 3in wide. The difference in height does not strike one immediately on seeing an American locomotive as other objects with which it might be compared are similarly proportioned, but one is under no illusion when attempting to converse from ground level with someone in the cab or when climbing into it.

Even when these differences in cross-sectional dimensions are taken into account, it is notable that many American locomotives weigh more than twice as much as the heaviest non-articulated locomotives in Britain and the world's largest locomotive is more than double the weight of ex-L.N.E.R. Garratt No. 69999.

Tenders are proportionately much larger still as one class, running on two eight-wheel bogies, with a laden weight of 193 tons, is about three times as heavy as the biggest British tender. Locomotive axle loads commonly exceed 30 tons, and in the Chesapeake and Ohio 2-6-6-6 reach 37½ tons, as against a maximum of 22½ tons here.

(In this article the ton is 2240 lb. The weights given for passenger vehicles are approximate; the British practice of inscribing the tare weight on every coach is not normally followed in America, although all freight vehicles are marked with tare weight and maximum load.)

Perhaps the most favoured wheel arrangement in modern American steam locomotives is the 4–8–4, large examples of this type being widely used in passenger and fast freight service; the smallest locomotives normally employed on main lines are 4–6–2s for passenger trains and 2–8–2s for freight. Boosters have not been so commonly included in recently-built locomotives as was the case twenty years ago.

Two-cylinder engines are the rule and the development of tractive effort, as large as the adhesion weight will permit, demands connecting-rods and coupling rods of the substantial cross-sections that can often be appreciated from photographs. On the other hand, American valve gear is light, not only by contrast with the remainder of the motion, but the rods are actually of smaller cross-section than is common in Britain for working considerably smaller valves. Walschaerts valve gear is the general favourite, but the New York Central system is one on which Baker valve gear is standard.

Instead of the simple Ramsbottom packing ring, segmental rings of comparatively elaborate construction are normally used for pistons and piston valves. No use seems to be made of the piston valve with six or more narrow rings, now in favour in Britain because of its low-leakage characteristic.

There is a tendency to favour the multi-ledge crosshead, involving somewhat awkward construction, but having the advantage that the sliding surfaces are comparatively well protected against dust and dirt. The use of floating bushes on crank-pins and lubrication by grease is common practice; the material normally used is fairly hard at atmospheric temperature and begins to lubricate only when the journal has become warm. Grease lubrication is standard for plain-bearing axleboxes. Cylinders, valves and the steam cylinders of air compressors are normally fed with oil by a mechanical lubricator; hydrostatic lubricators are not commonly used on main-line engines.

Roller bearing axleboxes are being increasingly used and win general approval as no attention beyond occasional lubrication is necessary and a life of at least a million miles may be expected. They also afford a reduction in rolling resistance, particularly at low speeds, but until pistons and piston-rods can also be made to run on roller bearings, it will not be possible to believe the suggestion implied by photographic publicity some years ago, that a young lady of normal proportions could move 300 tons of 4–8–4 and tender on level track by pulling it with a rope. It is said that the use of roller bearings for coupled axles makes a locomotive more liable to slip, particularly at low speeds.

It is usual to make the frame, cylinders, smokebox saddle and compressed air reservoir in one piece as a steel casting, perhaps 60ft long, and the same mode of construction is used for the foundation of the tender and for all the truck frames. The rear end of the locomotive is supported in many cases by a four-wheel truck pivoting about a vertical pin fixed in the main frame close behind the last coupled axle. The weight is sometimes applied to the truck through two spur gear pinions each trapped between two slightly curved toothed segments, one attached to the main frame and one to the truck. The curvatures (concave towards each other) of the segments produce a graduated centring effect. In later years this construction seems to have been less favoured than the use of heart-shaped rockers.

Coupled wheel-centres are usually made from cast steel in the form of two discs with a few large tubular distance-pieces between them, or (to regard the same thing in a different way) in the form of a wheel with a few spokes of large box-section.

Axlebox clearances in the vertical guides are usually taken up by wedges, often spring-loaded to provide automatic tightening. The first and last driving axles in any group of four or more have axial play to ease the motion of the engine round sharp curves, but also have spring restraint so that the duty of guidance round moderate curves is not thrown entirely onto the leading and trailing trucks.

The pilot, or cow-catcher, is usually a heavy steel casting of smooth-frontal form, designed so as to minimise the chance of diverting any part of a stricken automobile under the wheels of the locomotive. To this end also the front coupler is arranged to swing in one direction or another from its operating position when not in use and thus to eliminate a projection that has a tendency to become entangled with wreckage and then to drop it in the wrong place.

Firebox

The wide type of firebox is universal, with round top except that the Belpaire formation is standard on Pennsylvania Railroad locomotives; it is also used on the Great Northern Railway. Inner fireboxes are invariably made of steel and stays in the breaking zone are often of the flexible type, with ball-and-socket outer ends. It may be remarked that the British use of inner fireboxes made of copper, whose coefficient of thermal expansion is higher than that of steel, would seem to impose greater strains on plain stays than do all-steel fireboxes and yet flexible stays are rarely used here. The firebox may contain arch tubes extending from the front sheet to the top of the back sheet, "circulators," which are inverted "T" tubes, connecting sides and roof, or Nicholson thermic siphons; as many as five of any one of these devices may be found in one locomotive.

Ashpans are open at the sides of the firebox and slope gently inwards to join a vertical-sided section with bottom doors between the frame members. Jets of water or steam

may be provided to quench ash and to blow it from the shallow sides of the ashpan into the deep, central section. The close control available over a stoker-fed fire makes ashpan dampers unnecessary.

Firegrates are composed of grids about 3ft long and 10in wide, pivoted on horizontal axes parallel to their long edges and to the axles. The grids in each sixth of the total grate area can be rocked simultaneously by hand operation (sometimes with power assistance) of a lever in the cab. Restricted movement of the lever causes fine ash to trickle through the air spaces. A longer stroke, used with discretion, causes small pieces of clinker to slide into the ashpan through spaces opened up between adjacent grids, while use of the full stroke, which turns the grids through nearly 90 deg., dumps all the fire into the ashpan.

Mechanical Stoker

For feeding grates of locomotives in fast or heavy service, (and under legal compulsion on all engines with more than 78 tons adhesion weight), mechanical stokers are used (see Fig. 1). These are supplied by specialist manufacturers each with several different models, but they are all alike in principle. Coal is moved by a screw conveyor from the tender to a heat-resisting steel table in the firebox just below the normal firehole, and from there it is blown by steam jets on to the fire already in the grate.

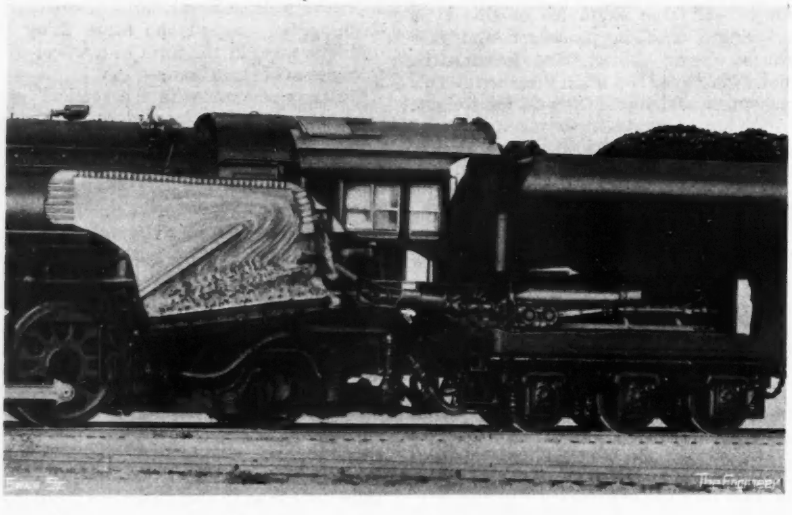


Fig. 1—Arrangement of Locomotive Stoker

That much about locomotive stokers is already well-known by British readers of literature on the subject and they probably have less difficulty in believing it than does one who sees the stoker at work for the first time.

It must be remembered that an American locomotive grate 8ft wide and 12ft long is nothing unusual and the uniformity with which fuel is spread over such an area by five steam jets fixed below the firehole seems almost supernatural. When a stoker starts to feed an incandescent fire, coal can be seen to pass from the table to points 2ft or 3ft ahead, but near the front wall of the firebox it appears as if by magic; it moves too fast to be seen on the way. The jets are usually set so that the firebed is thicker under the distribution table and in the rear corners of the firebox than elsewhere.

Another remarkable fact is that the usual depth of the firebed is less than 4in. This is notable because in British practice such a thin fire would have to be continually watched in order that prompt attention might be given to the holes that would be very apt to form in it, whereas on an American stoker-fired engine the fire may go uninspected for an hour at high power.

The reason for this stability of the thin, stoker-fed fire seems to be connected with difference between American grates and those used in Britain, the former having a lower ratio of air space area to nominal grate area than is usual here. (This is a trap for the unwary in comparing apparent combustion rates in British and American locomotives.) A consequence is that whilst the draught clears ways for itself through the fuel-bed, the grate bars are wide enough to retain a layer of inch-cube coal (which is the average size delivered by the conveyor). The continuous feed from the jets soon fills up any small gap that may form and in normal circumstances no large hole ever appears in the fire, although this can happen, if the engine is allowed to indulge in a bout of furious slipping. It is usual for a stoker-fire to "dance" over its whole area (thus helping to maintain uniform thickness) and if it does not do so it is unnecessarily deep. It is said that much of the coal blown into the firebox by the steam jets never reaches the firebed at all, but burns before it can do so. Whilst one may accept the first point without difficulty one may hesitate over the other; some of the coal that does not reach the firebed is probably only partly burnt when ejected from the chimney. (In an issue of the Baldwin house journal it was mentioned that in a full-power test of a fairly modern locomotive, as much as 44 per cent of the coal delivered into the firebox escaped unburned through the chimney.)

Whilst the stoker is beyond praise as a reliable device for maintaining a uniform fire in a large firebox, the thermal efficiency of a stoker-fired boiler may leave something to be desired because of loss of steam in the jets and loss of fuel through the chimney. Some of the older engine men believe that where the labour involved is not unreasonable, hand-firing is preferable to mechanical stoking; this idea is of greater importance to Britain than to America, where most of the locomotive work is too heavy for hand-firing.

But by far the most surprising feature of the stoker-fed fire is its impermanence. Three minutes after the stoker is stopped, only the deeper part of the fire at the back of the grate is likely to be incandescent and in twenty minutes that also may have died out. This characteristic differs so much from anything that occurs in British locomotive practice that it did not occur to the writer as the explanation of the feeble and localised nature of the glow in the ashpan of the first American locomotive he saw during a station-stop between spells of hard running. It is also very remarkable that an almost dead fire is brought back to nearly full intensity by less than a minute's application of the stoker.

It will be seen that stoker-firing affords a measure of control comparable with that of oil-firing and one admirable consequence is that the American travelling public are not subjected to anything like the uproar created in British railway stations by steam "blowing off" from safety valves. On the other hand, firebox temperature changes such as occur quickly when a stoker is stopped are usually regarded as detrimental to plates and tubes.

American locomotives are normally supplied with "run of mine" low grade small coal, which, in appearance at least, is inferior to what is normally supplied to main line locomotives in Britain. Stoker-firing offers the maximum opportunity for slack and dust to be carried away unburnt and that this does happen seems to be confirmed by the normally dark colour of the chimney discharge. This effect and the turbulent condition of the fire bed combine to restrict the formation of large clinkers from dirty coal, while the rocking grate can be used conveniently to dispose of any that do appear.

Boiler Auxiliaries

Some locomotives have a "smoke consumer" in the form of steam jets projected through large-diameter hollow firebox stays up to six in number, on each side of the firebox below the level of the brick arch.

Of fairly wide application in modern American practice is a low-water alarm in the form of a steam-whistle that emits a piercing note, when a float carried by the boiler-water remains below a predetermined level for more than about half a minute. An alternative device is worked by the thermal expansion of a tube, whose temperature rises when the static water that it normally contains is replaced by steam as the water level in the boiler falls to the danger point.

A steam turbine-driven centrifugal pump is normally used to deliver water from the tender tank to a feed water heater, whence it is forced into the boiler by a reciprocating pump. Live steam injectors are normally used as reserves; exhaust steam injectors are to be found on some locomotives, but are generally regarded as less reliable than live steam injectors.

It is normal to use a front-end regulator (or "throttle") usually of the multi-valve type between the superheater and the cylinders. The control handle projects horizontally from a lever suspended from a lever pivoted near the cab roof and swinging fore and aft in a finely notched segment. Connection between lever and throttle is by rodding outside the boiler and connected to opposite ends of an equal-armed lever pivoted on the boiler at the half-way point in order to eliminate any inaccuracy that might result from differential thermal expansion of boiler and rodding. Pneumatic assistance is provided in some cases.

One type of boiler pressure gauge has a dial and needle on each of the two flat faces and is mounted over the firehole in such a way as to present a face almost squarely to each of the crew.

Some locomotives have gauges showing the

pressures in the steam chest and in the base of the blast pipe. Exhaust steam pressure gauges are usually marked at a point representing a pressure that should not be exceeded in normal running, and are often arranged to indicate blast-pipe pressures below atmospheric pressure, an undesirable condition that may occur when drifting.

Cut-off Control

The "Valve Pilot Indicator" is a track-speed indicator fitted with an extra needle, whose position is determined by that of the reversing gear. The connection between reversing gear and indicator includes a cam that is shaped to suit the characteristics of the class of locomotive concerned. The best cut-off for maximum power at any speed is found by moving the reversing gear so that the needle connected with it gives the same dial reading as the speed-indicator needle. The face of the gauge is graduated only in m.p.h., and gives no indication of the cut-off as a percentage of the stroke. It is understood that a Valve Pilot indicator has been tried in Great Britain but rejected because it was said to have led to higher fuel consumption than when it was not used. This result is not surprising on work involving frequent starts as use of the Valve Pilot in the intended manner gives the highest acceleration of which the engine is capable and this, of course, is in complete contrast to the leisurely British practice of what is sometimes described as letting the engine find her own pace.

Power-operation for the reversing gear is a legal requirement in the U.S.A. even where (as with poppet-valves) the physical effort required to reverse the engine is well within a man's capabilities.

A double-acting air cylinder is used for moving the reversing shafts of engines with Walschaerts or Baker valve gear; the Franklin system of steam distribution by poppet valves includes a small air motor to rotate the control shaft.

Air sanding is universal and in some cases use of it is accompanied by the blowing of a small whistle as a reminder to the driver that air and sand are being expended.

Some locomotives with more than one group of driving wheels, e.g., the Pennsylvania class "Q2" 4–4–6–4 illustrated above, have a "slip suppressor," which operates on a butterfly valve to restrict the steam supply to one engine if the speed of the wheels that it drives appreciably exceeds that of the other driving wheels. A friction disc is spring-loaded against the tread of one driving-wheel in each group and chain drives cause the rotational speeds of the discs to be duplicated in two members of a "differential switch." Relative rotation of these two members causes a brush to pass over commutator segments say, *A*, *B* and *C*, with the result that electrical impulses reach certain solenoids. There is a time-lag in the de-energisation of the solenoid connected to *B* and when that solenoid is completely de-energised, electrical impulses applied to *A* or *C* have no effect; this is the case when the relative speed of the two engines is low. If, on the other hand, an impulse reaches *A* or *C* whilst the solenoid connected to *B* is still effective, the impulse is transmitted to a solenoid that works through a pneumatic relay to restrict the steam supply to the faster running engine.

Brakes

Locomotives have straight air brakes with hand control, but the brake may also be automatically applied proportionately to the braking in the normal Westinghouse system used on all vehicles, passenger and freight. The compressors are of the Westinghouse type cross-compounded in steam and air and usually mounted on the smokebox or immediately below it behind heavy plate protection against level crossing jetsam. The larger engines have two compressors which are often almost inaudible in operation, although the reactions of the pumping strokes can sometimes be felt in the cab or even on the ground beside the engine.

The latest types of tender have an emergency brake valve at the front end; this is for use in case of any mishap that compels the enginemen to leave their normal positions in the cab. It is now a legal requirement in the U.S.A.

Neither locomotives nor tenders are normally fitted with hand brakes and as the air brake fades by leakage when the pump is stopped, "parked" locomotives are secured by a short length of chain laid on the rail before and behind a wheel.

Cab Details

Cabs are wider than in Britain and they have rear protection against the extremes of cold weather in North America. On engines that do some or all of their work on freight trains, the cab contains an extra seat for the head brakeman, although on the Pennsylvania Railroad he is accommodated on the tender in a special shelter that is an elaboration of the "iron coffin" of the G.W.R. early broad-gauge days. Lamps for head lighting, gauges and general cab lighting are energised by a steam-turbine-driven generator usually mounted on top of the boiler and exhausting to atmosphere. On some engines, lamps are provided to illuminate the injector overflow pipes at night.

Cab signalling apparatus is to be found in many locomotives. In some cases a continuous indication is given of the aspect of the next signal ahead; in others, light and sound indications are given only when passing signals or other special points.

For giving warning of approach to level crossings, a deep-toned whistle is normally provided. Four blasts are given for each crossing and on certain routes this occurs with a frequency that some passengers would find trying if the sound were very noticeable in the train.

In compliance with a legal requirement, motion of a locomotive in station limits is accompanied by the sounding of a bell; this is usually worked pneumatically and with measured, high-pitch beats, generates a dolorous clangour reminiscent of Edwardian Sundays in the smaller towns of industrial Britain.

Within the limits of the City of Chicago, engine-men are forbidden to sound a locomotive whistle "except when necessary to prevent injury to life and property or when necessary to warn or signal employees or the public." This would be a useful move towards noise suppression if accompanied by the British embargo on the use of automobile hooters between 11.30 p.m. and 7 a.m. but in view of the noise in Chicago and other American cities, it has the aspect of mere spite against railroads.

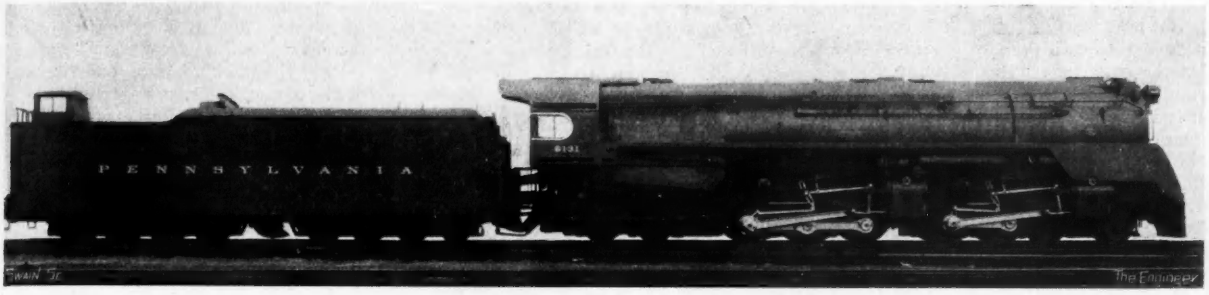


Fig. 2—Pennsylvania Class "Q2" 4–4–6–4 Freight Locomotive

Tenders

Tenders are of impressive size and capacity even when provided with water pick-up scoops as on the New York Central and Pennsylvania lines. In the former case the latest tenders are distinctive in their overflow pipes, six on each side, designed to avoid the swamping of the head-end of the train that occurs when the tender is overfilled at speed. (In The Engineer for January 21, 1944, page 53, the writer suggested that some such provision might be desirable, but the only written comment doubted its practicability). With this safeguard it was possible to give the name "Niagara" to the New York Central 4–8–4 class without risk of comment on the discomfort of running a train behind a waterfall.

Tenders are often loaded with coal to a height well above any part of the engine, but as the coal used is invariably small, the danger from pieces displaced by vibration or contact with overline structures is less than in Britain where the same undesirable practice is common with large coal despite an official statement to the effect that it never happens, because the construction of the coaling plant makes it impossible.

Tenders are normally built on cast steel beds supported by two cast steel trucks, each with up to eight wheels, although in some cases (e.g., the fourteen-wheel N.Y.C. tenders mentioned above) a four-wheel truck supports the leading end, whilst the remaining axleboxes slide in horn blocks formed in the main bed.

All vehicles are connected by automatic couplers combined with central buffing gear of the same general type as the Buckeye coupling used on many ex-L.N.E.R. passenger vehicles, but the American couplers may be

engaged without using the impact that appears to be necessary to make any useful impression on some samples of the British Buckeye.

Operation

American locomotives on long-distance trains have to work hard to maintain time and the freight engines indeed often run continuously with full-open regulator at 60 per cent cut-off even on level or only slight gradients. As in Britain, short-distance passenger trains are usually over-engined.

A heavily loaded locomotive may be unable to start its train except by making use of the coupler slack, which is about 6in for each pair, and so it is not unusual for the rear vehicles of passenger trains to be started with a violent jerk. Modern passenger cars run on roller bearings whose low static resistance obviates any need to use "free slack" of couplers when starting and has therefore permitted the fitting of "tight-lock" couplers. Trains of such vehicles normally start and stop quite smoothly.

Soon after the first start made by each train, the brakes are applied at a speed of about 20 m.p.h. with the engine still pulling so that the engineer may satisfy himself by the resulting retardation that normal brake power is available. This is a requirement on all American railroads.

It is rare to work an engine at less than about 25 per cent cut-off; the usual minimum is over 30 per cent with partly closed throttle if that will produce the effort required. The relation between boiler power and nominal tractive effort in main line engines is such that full throttle opening may be used at full speed with over 60 per cent cut-off, and freight engines frequently run in that condition at 40 to 50 m.p.h.

Acceleration of passenger trains seems to be generally faster than in Great Britain, a relatively late cut-off being maintained on the locomotive until full speed is attained. Passenger vehicles ride smoothly and quietly, which proves that tracks are well maintained, although, even on high-speed main lines, the warped and cracked condition of most of the sleepers is something quite unknown even on the lowest grade of track in Great Britain.

Station stops are effected more slowly in America than is common here at the present time, and the very smart stops that were regularly made at such places as Leamington and Leicester in the days of our fastest running were quite different from anything observed by the writer in the United States.

It is a specific part of the engineer's duty to work the engine as hard as may be necessary to bring a late-running train back to schedule time as quickly as possible. This is in marked contrast to British conditions where locomotives with featherweight trains are often allowed to drift along at scheduled speed even though well behind time. The American practice is facilitated by the general use of mechanical stokers on large locomotives, although it also applied, within the limitation of the fireman's endurance, in the days of hand firing.

Coal and Water

Coal consumption is naturally much heavier than in Britain, and by contrast with normal running of express passenger trains over about 400 miles from London to Glasgow or Edinburgh on less than 10 tons of coal, it was surprising at first to hear that 22 tons of coal barely sufficed for an 80-mile journey with an American freight train over a slightly undulating road. When it is remembered, however, that the freight train may weigh 8000 tons it is found that its coal rate per ton-mile is not excessively heavy.

For re-fuelling engines on long-distance workings, coaling plants span the main lines at certain servicing stations, e.g., Wayneport, N.Y., and Elyria, O., on the New York Central main line from New York to Chicago. On that route, engines take their trains over the 927 miles from Harmon to Chicago and are twice re-fuelled on the way, although the 41-ton coal capacity of the latest tenders might just suffice to avoid that necessity. From the point of view of economy of time it would be useful to re-fuel engines at a station stop, but American civic authorities have a horror of smoke and grime and so no railroad company would presume to erect such a dusty edifice as a coaling plant at a city station. In some cities, fines for smoke-emission from locomotives are imposed on the engineers concerned and not on the railroad company.

Great pains are taken to minimise the use of steam locomotives in sub-surface stations in large cities. (A large station is often called a "terminal," but this does not necessarily mean a terminus as understood in Britain.) Of this perhaps the most striking example is at Cleveland, O., on the New York Central main line. Every west-bound through train stops at East Cleveland, where the steam locomotive is replaced by an electric one for haulage over the 7 miles to Cleveland Union Terminal (central joint station), and then for 6 additional miles to Linndale, where the steam locomotive awaits it after having followed a route that by-passes the Union Terminal. Corresponding procedure is followed with east-bound trains. As diesel locomotives are now allowed to work through the terminal, a time may come when the electrified system in this vicinity will have no further use.

It is usual to reduce speed to 50 to 60 m.p.h. when picking up water from a trough. On the New York Central system such a reduction is obligatory unless it is clear that there will be no train on the adjacent track at the time of picking up, or unless the tender has "overflow control" pipes that discharge any overflow close to rail level.

During a coaling stop and often at station stops, locomotives on long runs are serviced by men from the local running shed. This operation includes replenishment of grease and oil receptacles, fire cleaning if necessary and emptying of the ashpan. The enginemen are not officially permitted to take part in these activities as additional duties qualify them for extra pay at uneconomic rates. The driver of a main line passenger engine can, for example, claim extra pay for shunting duties if he is required to use his engine for changing the formation of his train by adding or detaching a vehicle.

On the Road

Over the greater proportion of American railway mileage the engineer's duties are a shade less exacting than those of an English driver because of the greater distances between signals. On the Pennsylvania main line, signals are of the position-light type, three lights on a horizontal line meaning "stop," and three on a vertical line meaning "clear." Additional lights below the main indicator are shown in various combinations to indicate "approach-medium," "medium-clear," "approach," "caution," "slow approach," "permissive-block," "restricting" and "stop and proceed," a formidable list by British standards. As in Britain, adequate warning is afforded even if a signal is not visible until the engine reaches it, but it is natural for the engineer of a fast train to desire the earliest possible view of each signal, and in bright sunlight at least a British semaphore with normal background is readable at a greater distance than the ordinary position-light signal in America.

The fireman is supposed to keep a look-out for signals (presumably with the saving clause "except when otherwise necessarily engaged") and the enginemen should transmit their readings of the signals to each other by calling out the official descriptions of what they see.

The most dangerous feature of American railroad operation is the level crossing with public roads. Outside city limits no gate, pole or other physical barrier is normally provided to restrain the recklessness of road users and despite the provision of warning bells and flashing lights at many crossings, collisions on crossings are not uncommon. Of these only a small proportion cause derailment of the train, and engineers (influenced, no doubt, by the weight of the engine and their distance from the front of it) are not appalled by the sight of an automobile "stalled" on a crossing. They make a heavy, but not panic-stricken brake application, hide behind the boiler before the moment of impact, and then stop the train reasonably quickly before removing the more easily detachable wreckage from the engine and examining it for serious damage.

It is usual practice when meeting a train on an adjacent line for the engineman nearest to it (usually the fireman) to leave his seat and to stand within the boiler outline until the other train has passed, so as to be clear of the worst effects of any collision between the front corner of the cab and anything that might be projecting from the other train.

The use of the mechanical stoker makes the fireman's duty a comparatively easy one, and as no coal is passed through the cab, dirt in the air is limited to that which finds its way back from the chimney. Consequently the working conditions are cleaner than on hand-fired locomotives, and American enginemen, clad in light-coloured, fine-striped overalls, wearing a long-peaked cap, gloves and (often) rimless spectacles, present an appearance notably different from that of their British counterparts. Even when about to work a train over 200 miles or so they may go to the engine empty handed as canteen facilities make it superfluous to carry food, and a large water bottle is part of the locomotive equipment.

(To be continued)

Coal Preparation Plant for Turkey.—Simon-Carves, Ltd., in competition with American, French, Belgian and German firms, have received an order worth just over £2 million for new coal preparation plant in Turkey. The order has been placed by the Eti Bank on behalf of the Eregli Coal Mines; it embraces two complete washeries at Zonguldak and Catalagzi, on the southern shore of the Black Sea, and dirt-handling plants for dumping the discard from both washeries into the sea over distances of about a mile and three-fifths of a mile, respectively. Coal and coke-handling plant and a dumped rock crushery are also included. The washeries will be among the largest in the world, the Zonguldak plant treating 750 tons per hour of run-of-mine coal and the Catalagzi plant 500 tons per hour. The Zonguldak plant comprises three Baum units and four fines treatment plants, the Catalagzi plant having two Baum units and three fines plants; the fines plants include froth flotation, flocculation and filter-cake drying equipment. Both washeries will have fully automatic control and means for the continuous automatic sampling of all washed products. The dirt-handling plants carry the discard on belt conveyors, running first in overhead gantries and then in tunnels through the mountains. Discharge into the sea takes place from cantilevers about 300ft above sea level, these being provided with warning beacon lights for shipping. The work is expected to take about two years to complete.

Control System for Nail Polishing Plant

THE manufacture of wire nails in the reorganised factory of Rylands Brothers, Ltd., at Warrington, Lancs., has been planned on a scale that makes it the largest nail making plant in Europe. Regular production varies from nails 10in in length and weighing three to the pound to ¼in in length and weighing 10,530 to the pound. The total consumption, of steel for this purpose is 700 tons per week, but will be increased to 1200 tons as soon as supply conditions permit.

After the nails are formed they are polished by tumbling and a carefully-planned automatic control system for this plant has been designed, made and installed by Salford Electrical Instruments, Ltd., in conjunction with Rylands Brothers, Ltd.

Briefly, the requirements are threefold. First, twelve polishing machines are installed and have to be kept supplied with unpolished nails, the batches being left in the machines for various times, depending on the size and type of nail.

Secondly, the machines are loaded by a crane and the crane-driver receives instructions to pick up unpolished nails which may be waiting at any one of three points. One of our illustrations shows a general view of the polishing plant with skips of nails in the foreground.

Thirdly, the polished nails have to be discharged on to a conveyor for removal to bagging and stitching machines, with the stipulation that the conveying system must not be overloaded.

The control system to cover these conditions is fully integrated, i.e., it embraces electrical interlocking, visual and aural signalling, electro-mechanical servo-mechanisms and, as an ancillary, pneumatic message carrier tubes. The main components of the control system are telephone relays and telephone-type uniselectors. Further, to increase the simplicity and reliability, the design is such that there are no relay sequences which depend on critically adjusted relays.

As illustrated herewith, the control panel is approximately semi-circular in form, so that the operator can reach all the controls from a sitting position. Telephones and a receiving station for pneumatic message carriers, are at hand, though not shown in the illustration.

Each pair of rumblers is allotted a control unit consisting of one of the six control panels embodied in the desk. The upper and lower sections of each unit are for signalling and switching purposes respectively, and the two pairs of concentric dials are associated with timing. The outer dial can be set manually to the desired polishing time, which depends on the kind of nails being handled. When polishing is taking place, the inner dial is stepped round at one minute intervals by means of a telephone-type uniselector and indicates to the control operator the number of minutes of polishing time still to run.

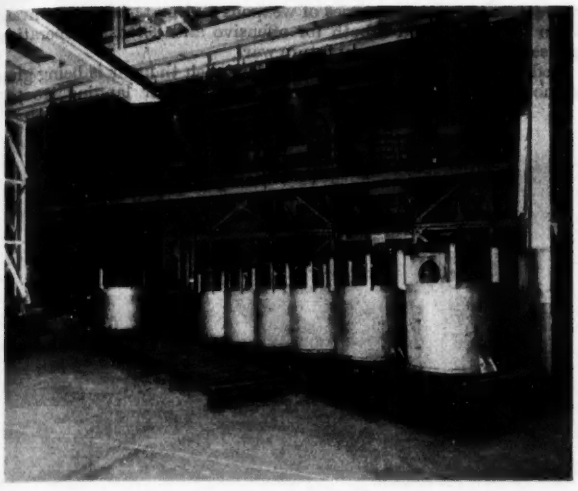
Operation of the control system can best be understood by describing an actual polishing sequence, and for this purpose, it is assumed that two rumblers are idle and are to be brought into use, the twelve rumblers being grouped in pairs.

When the rumbler motors are started, the "rumbler running" lamps at the top of the panel will light from the line/neutral supply to the motors, and a relay in the same circuit will operate and switch on the power supply to the control circuits.

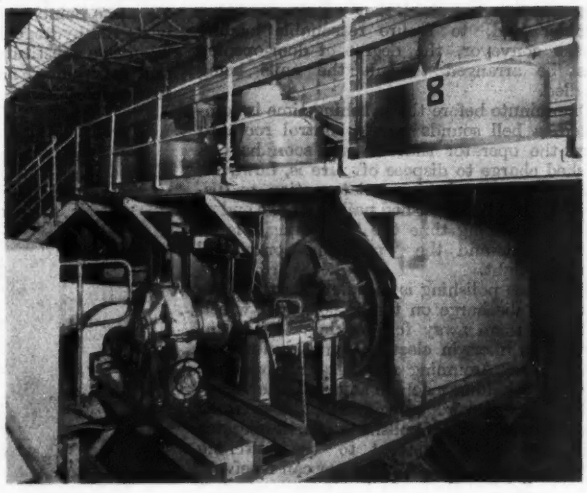
The operator then presses the "door position closed" button and the servo-mechanisms, which control the exit door of the rumbler, will operate to close the door, should it be open. The rumbler is now ready to be loaded and the "can receive charge" lamps below the "rumbler running," will light.

The operator will have previously been informed by pneumatic tube at which pick-up point the unpolished nails are awaiting attention and he passes this information to the crane-driver by throwing a key corresponding to the required pick-up point. The three keys are shown centrally below the panels in our illustration of the control desk. The operator also moves the "crane signal" key at the top of the panel unit to "on." This causes an indicator lamp to light and shows the crane-driver the rumbler into which he is to deposit the load. Operation of the "crane signal" key causes the "can receive charge" lamp to go out, but if the control operator wishes to nullify the instruction which he has just given, he moves the "crane signal" key to "cancel." This will extinguish the indicator lamp visible to the crane-driver and when this is done the "can receive charge" lamp will re-light.

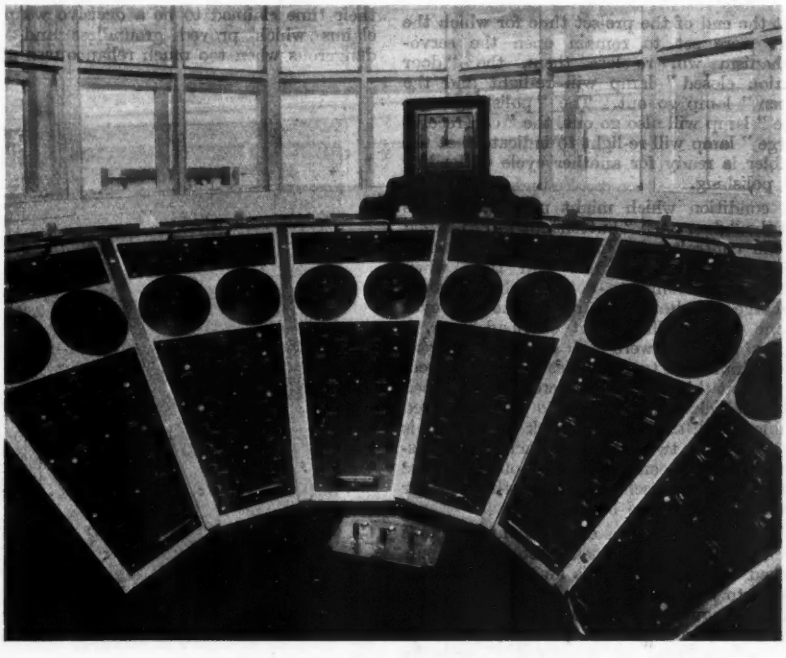
When the charge of unpolished nails is deposited in the designated rumbler by the crane, a switch is operated by the skip con-



LOADED SKIPS ALONGSIDE NAIL POLISHING PLANT



SERVO MECHANISM



NAIL POLISHING CONTROL DESK

taining the nails and the "polishing" lamp lights. Simultaneously, the first pulse is applied to the uniselector which drives the inner timing ("minutes-to-go") dial. Further pulses are applied at one minute intervals determined by a synchronous clock.

Once polishing has started, the interlocks which have been incorporated in the control system, make it impossible for the control room operator either to signal the crane-driver to deposit a second charge in the same rumbler or for the rumbler door to be opened. The control room operator can, however, pre-select the degree to which the door will be opened later. He does this by pressing the corresponding button in the lower part of the control panel, the buttons being marked with quarter fractions of opening from closed to full open. This provision is necessary because the size of nails being polished determines the speed at which they will flow from the rumbler and, to secure reasonable loading on the conveyor, the degree of door-opening must be arranged to suit the nails being handled.

One minute before the polishing time is completed, a bell sounds in the control room to warn the operator that he will soon have a finished charge to dispose of. He is, however, not obliged to take immediate action to discharge the load of polished nails. At the end of the full polishing time the "polishing" lamp will go out and the "polishing complete" lamp will light.

When the polishing is complete the nails are ready for discharge on to the conveyor which will take them away for packing. This conveyor is a Sherwin electro-magnetic vibratory equipment. Assuming now that an operator on a bag-stitching machine at the "receiving" end of the conveyor has decided that his machine can accept a charge of polished nails, he operates a manual signal adjacent to the stitching machine, which causes "conveyor can receive" lamps to light on the control units with which it is associated. If now the control room operator has already pre-selected the "door position" button the servo-mechanism will automatically open the rumbler door to the desired degree and the nails will discharge on to the conveyor. The "conveyor can receive" lamps will also go out. One of our illustrations shows a close-up view of a servo-mechanism. The time for which the doors remain open may be pre-set (up to a maximum of ten minutes) by means of internal controls, but these are only adjusted when the plant is first put into operation, because all normal variations of discharge can be obtained by varying the degree to which the doors are opened, say, one-quarter or one-half open for small nails and three-quarters or full open for large ones.

At the end of the pre-set time for which the doors were set to remain open the servo-mechanism will re-close them, the "door position closed" lamp will re-light and the "open" lamp go out. The "polishing complete" lamp will also go out, the "can receive charge" lamp will re-light to indicate that the rumbler is ready for another cycle of loading and polishing.

A condition which might possibly arise is that the "door open" buttons might be pressed on the control units of two rumblers while polishing was in progress and then when polishing was complete both machines would discharge simultaneously on to the conveyor at one point. This might overload it or, if the two rumblers were each handling different types of nails, the two varieties would be mixed. To prevent this happening there is an interlock system which gives priority to odd-numbered rumblers and, as the units work in pairs, it is impossible for two adjacent machines to discharge on to one conveyor even though they are both ready for discharge and both the door control buttons have been pressed.

The only other item on the control panels which has not been mentioned is the key marked "over-ride." This key is used if it is desired to discharge a load before the normal polishing sequence has been completed. When is is moved to the "on" position, it enables the rumbler doors to be opened at once by pressing the "open" button. If it is moved to the "cancel" position the timing mechanism for re-closing will be cancelled and the rumbler door will remain open indefinitely. This facility is necessary in order that occasional blockages may be cleared.

The design and engineering of the complete control system was carried out by Salford Electrical Instruments, Ltd., Salford, Lancs., and the material for this article was provided by Mr. J. Foster Veevers, M.I.E.E., and Mr. H. J. Clark, B.A., who were responsible for the work.

Opposed Landings

(By Our Naval Correspondent)

IN urging the Western nations to increase their defence forces while there is yet time, Mr. Churchill is wise in emphasising that the atom bomb stockpile in the United States can only be a short-term safeguard. For the atom bomb (or its still more deadly counterpart, the hydrogen bomb) can never be relied upon as a substitute for land, sea and air forces and may indeed never be used at all through fear of retaliation. Gas was not used in World War II because both sides knew that the other had a stock ready to deliver if his enemy started using it, and we may be sure that Russia will not precipitate a major war until she, too, has a large stockpile of atomic bombs. Moreover, the history of war shows that no one weapon is ever decisive, in spite of the claims made for it—the long bow, the war elephant, the cannon, the tank and the large heavy bomber were all in their time claimed to be a decisive weapon—claims which proved groundless and often dangerous when too much reliance was placed on the weapon. The Fighting Services—who are sometimes accused of preparing always for the last war—are fully aware of this, and with the limited means at their disposal are doing their utmost to ensure that the most effective types of weapons and material will be available both for offensive and defensive operations in any future war.

In particular much thought is being given to the material required for landing troops and establishing a bridgehead on a section of the enemy's coast which has been well prepared and fortified against attack. Many valuable lessons have been learnt from the last war, but the School of Combined Operations in North Devon, which is responsible for the training and organisation of personnel in this branch of warfare, must always have in mind the more formidable obstacles which will undoubtedly be encountered in any future war. The first essential is to get tanks ashore at the outset in support of the first wave of troops, and for this

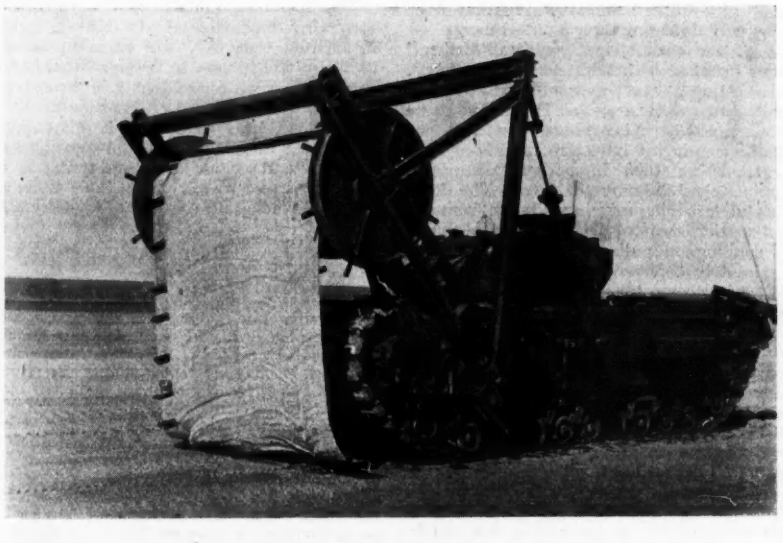
TANK EQUIPPED WITH BRIDGE

TANK EQUIPPED WITH RAMPS FORE AND AFT

purpose the methods used in the landings on the Normandy and Pacific beaches proved efficient and will probably be employed again. A standard tank equipped with a canvas screen high enough to make it float and with two propellers is launched at about 6000 yards from the beach from an L.C.T. (tank landing craft) and driven in under its own power, at a speed through the water of about 5 knots to 6 knots. The tank cannot fire, however, while the screen is up and can thus give no protection to the troops during the last few hundred yards of the run in, when naval gunfire has to lift. For this reason the Americans in their operations in the Pacific developed the tracked landing vehicle into an armoured tracked amphibian with a built-in turret mounting a 75mm howitzer which could fire on the run in. From the naval point of view it is undesirable that the first wave of troops should be accompanied by vessels specially designed to land tanks on an enemy beach—the landing ship, tank (L.S.T.) and the landing craft, tank (L.C.T.)—both because of the risk to these craft and the amount of beach room they occupy at the peak traffic period of the assault.

Having reached the shore, the tanks may find further progress interrupted by bad terrain and strong anti-tank defences, such as sea walls, wide and deep anti-tank ditches, minefields and even wide streams. Tanks of various types modified and adapted to deal with some of these obstacles were developed in World War II. In the accompanying engravings there are illustrated a tank equipped with a bridge to span a stream, another with ramps fore and aft to enable following vehicles to get over a sea wall, and a tank with a bobbin of matting which can be unrolled over soft ground or mud. Since the war these specialised tanks have been improved in design and organised into breaching teams, manned, in the British Army, by the Royal Engineers. It is intended that each team shall be composed of such types and numbers of these specialised tanks as may be required to land in the face of the particular obstacles disclosed by reconnaissance and aerial photographs. Three teams are allocated to each infantry battalion landing beach in the hope that at least two will be successful. They are commanded, not by the infantry battalion commander on whose beach they are to operate, but by a tank officer, and are not even considered to be in support of the infantry. Although taking place nearly simultaneously and in the same area, the infantry assault and the breaching operation are almost entirely unrelated.

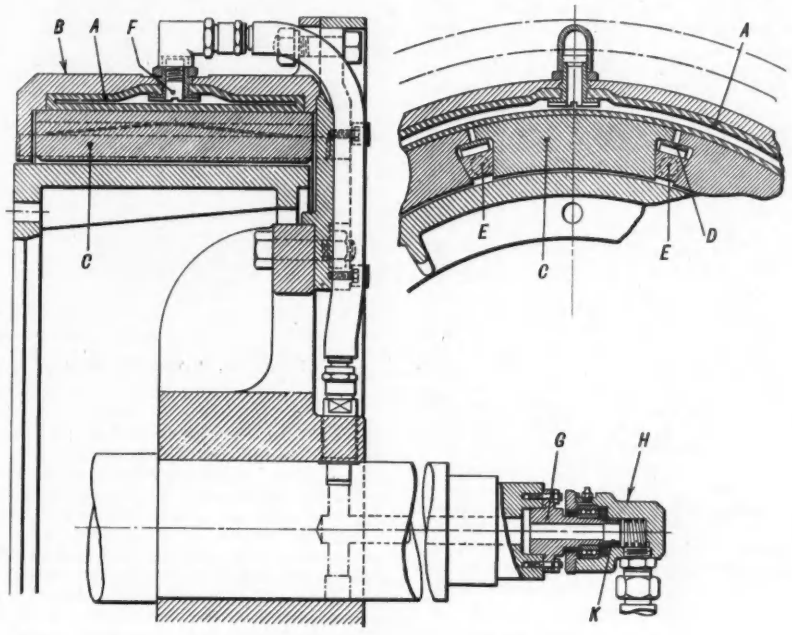
The intention is that the standard tanks —which have "swum" to the beach— should wait there and afford fire support to both breaching teams and assaulting infantry until the anti-tank defences have been breached and the infantry and armour as a whole can proceed through the enemy fortified defences and on to ground where the going is good. Thus the breaching tanks arrive at the beach a little after the first wave and are landed from L.C.T.s. They cannot be successfully floated and "swum" in like the standard tank because of the bulk and extra weight of their additional equipment. Nor would it be desirable to do so, as it is essential for the different types of armoured breaching vehicles in a team to arrive at the beach as one unit. If they were "swum" in, they might well become scattered or even swamped in a surf. The success of the breaching operation is so important that it is considered they should be ferried in on landing craft, even if it were possible to swim some or all of them ashore.



TANK EQUIPPED WITH BOBBIN OF MATTING

An Air-Operated Clutch

SOME time ago Crofts (Engineers), Ltd., of Bradford, acquired the manufacturing rights in this country of the "Airflex" clutch, which is made in the United States and the company is now making a wide range of these units for all forms of power transmission. A property of these clutches, which are operated by means of compressed air, is their smooth operation and comparatively light weight, and the fact that once installed they require little or no maintenance. The design is such that by small modification the clutches can be adapted as efficient brakes for a wide range of industrial applications. As expanding or constricting clutches or as brakes the units operate on the same principle—an annular rubber bag, expanded by compressed air, moves friction blocks into contact with the driving or driven member to transmit power or apply a braking force.



AIR-OPERATED CONSTRICTING CLUTCH

At present, Crofts (Engineers), Ltd., is making expanding clutches to this design for transmitting from ½ h.p. to 380 h.p., and constricting clutches for from 2·5 h.p. to 3000 h.p.

The "Airflex" clutch consists essentially of an annular rubber bag, heavily reinforced by fabric, and actuating a ring of friction blocks. The bag is set between the flanges of the driving and driven members of the clutch and by the admission of compressed air is expanded to lock the two members together to transmit the drive. Only a relatively small volume of compressed air is used to expand the bag and as long as the pressure is maintained power is transmitted. The speed at which drive is taken up, or a braking effect is applied, is controlled by the rate of admission of the compressed air. By using a large number of friction blocks power is transmitted over practically the whole circumference of the clutch, and the even distribution of pressure throughout the air cavity in the bag gives a smooth and positive pick-up of the drive. The fact that the drive is transmitted through a flexible medium makes it possible for the clutch to work efficiently with a small degree of angular or axial misalignment or end movement between the clutch members.

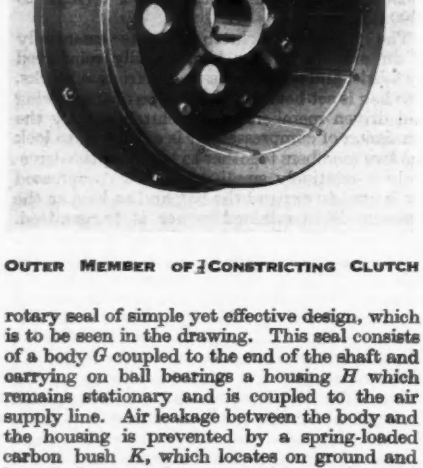
The constriction of the clutches can be followed with reference to the drawing we reproduce on this page, showing the arrangement of one of the constricting models. It will be appreciated that the successful operation and life of the clutches depends largely upon the design and manufacture of the air bags and

friction blocks. The wall of a bag which contacts the friction blocks is heavily reinforced by fabric to prevent the possibility of chafing of the bag between the slippers of the blocks. Local chaffing would naturally occur if the surface of the bag was not sufficiently strong to prevent it bulging between the blocks when under air pressure. The friction blocks are of special manufacture and each consists of an asbestos base to which is bonded a friction lining having high heat resisting properties. This form of block has been adopted to prevent the transfer of heat from the friction lining to the rubber bag.

Referring to the drawing of the constricting clutch which works with air pressures from 95 lb to 120 lb per square inch; the air bag *A* is situated between the clutch housing *B* and the friction blocks *C*. These friction blocks are kept in contact with the bag by means of flat springs *D*. Each of the springs sits upon a torque bar *E* situated between each pair of friction blocks. These torque bars, of hardened steel, are rigidly mounted between the sides of the clutch housing. Each spring exerts pressure upon the two adjoining slippers or feet projecting from the lower sides of the friction blocks, and the springs provide an effective and simple way of holding the blocks away from the inner clutch rim when the clutch is disengaged. It will be seen that when compressed air is admitted to the bag it expands to overcome the effect of the springs and slides the friction blocks forward into contact with the rim. The drive is then transmitted through the torque bars and side plates to the clutch housing.

The rubber bag is retained in position in the outer steel housing of the clutch by means of the air inlet valve *F* only. The use of this valve as a retaining unit has been found effective, as the friction between the rubber and the housing is higher than that between the friction blocks and the rim, and no creep takes place. No power is transmitted by the bag, its only function being to engage the clutch and to allow for slight inaccuracies in alignment.

Compressed air for operating the clutch is supplied through a hole bored through the length of the shaft and connected by piping to the inlet valve of the bag. The air under pressure enters the hole in the shaft through the



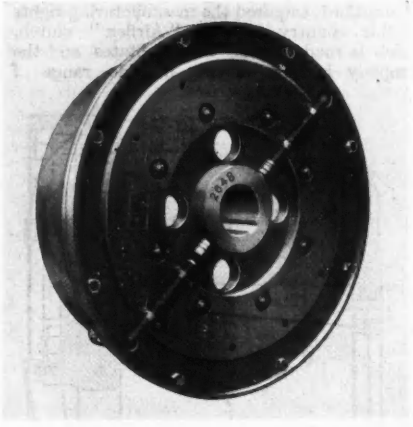
OUTER MEMBER OF CONSTRICTING CLUTCH

rotary seal of simple yet effective design, which is to be seen in the drawing. This seal consists of a body *G* coupled to the end of the shaft and carrying on ball bearings a housing *H* which remains stationary and is coupled to the air supply line. Air leakage between the body and the housing is prevented by a spring-loaded carbon bush *K*, which locates on ground and lapped faces to form a positive seal. The spring loading of the carbon seal compensates for wear in service and units have been in operation for as long as five years without need for attention.

The expanding type clutch which is used for comparatively low speeds has similar components to the constricting clutch and works on the same principle. In it the friction blocks are forced outwards instead of inwards when power is transmitted. In both types of clutch the design and arrangement of the friction blocks, springs, torque bars and other components vary according to the power to be transmitted, speed, &c., but the operating principle with an air bag remains the same.

It is pointed out by the makers that in addition to being light and simple to operate no adjustment or maintenance work is necessary during the working life of the components of these clutches.

They can be operated from stations adjacent to or situated at some distance from the actual



REAR OF OUTER MEMBER

units. When they are required to operate instantaneously, it is necessary to fit quick-release valves in the pipe-line or to operate large bore valves near the clutch by means of pilot valves or solenoid-operated valves. Solenoid operation is usually adopted for factory main drives so that the clutch can be disengaged some considerable distance away from the prime mover as required by the Factory Acts.

Some interesting tests have been carried out with these clutches, and during recent tests on a 32in unit, it was operated forty times in 6½ minutes against a heavy load. At the conclusion of the test the temperature of the rim was about 900 deg. Fah. After a number of similar tests the clutch was dismantled and it was found that the component parts, including the rubber bag, showed little sign of the drastic treatment the unit had undergone.

Clutches of this type, installed on excavators and oil-drilling rigs, have been used on the hoisting drums to transmit up to 750 h.p. at 390 r.p.m., and to pick up the full weight of a line of drill pipes about once per minute over working periods lasting three hours or more.

One of the earliest heavy-duty "Airflex" clutches installed by the firm in this country, is in operation at the paper mill of Cooke and Nuttall, Ltd., at Horwich. This clutch was installed in 1945 and is arranged to couple two 9in shafts running at 150 r.p.m., and is capable of transmitting 1000 h.p., day and night, approximately 150 hours per week. The drive to the clutch driving member is taken from the second motion shaft of a turbine by means of ropes running on pulleys of 10ft diameter at approximately 50ft centres. The surge which would take place on these ropes if the load were placed on them suddenly can be appreciated. The clutch is so controlled that a period of seventeen seconds elapses before full weight is placed on the ropes, and the load is taken up steadily and progressively as the driven shaft approaches full speed.

During a recent visit to the maker's works we saw in course of erection clutches to transmit 800 h.p. at 1200 r.p.m., together with units for use on presses which, when used in connection with special brakes, made by the firm, give excellent control of the press with the ram in any position.

Iron Ore Discharging Plant at Tyne Dock

As a result of the programme of extension and modernisation at the works of the Consett Iron Company, Ltd., it is anticipated that the company's requirements of foreign ores will increase in the future, one million tons of ore per year being the consumption which is ultimately envisaged. In order efficiently to handle this large quantity of material, it is planned to build a new quay at the Tyne Dock, together with the necessary rail facilities. Negotiations concerning this project have recently been successfully concluded between Consett Iron Company, Ltd., and the Tyne Improvement Commission.

To handle the increased quantity of ores in the most economical manner and to effect the quickest possible turn round of ore carrying vessels, the Commission will, under the arrangement, build an extension to the Sutherland Quay on the river at Tyne Dock, suitable for berthing vessels of up to 20,000 tons capacity. It is planned to install on the new quay modern ore discharging and handling equipment in the country. The cost of the project is estimated at nearly £1,000,000, and Treasury sanction will be required.

The ore will be discharged by a battery of five 10-ton grabbing cranes and will be weighed automatically as it passes from the crane hoppers on to conveyor belts, which load the main storage bunkers, having a total capacity of 7500 tons. These bunkers will be constructed to allow of further extension in the future if required. Travelling weigh cars will transfer the ore from the main storage bunkers to two sets of nine 56-ton capacity hoppers, so spaced as to coincide with the spacing of the wagons of the trains, into which the ore will be loaded simultaneously by the operation of electrically-driven doors on the hoppers.

British Railways have co-operated in the general scheme and will provide composite trains of specially designed wagons to be operated on a fast shuttle service between Tyne Dock and Consett.

A special ore gantry is being constructed at the Consett Iron Works to receive the loaded trains, which will be discharged in a matter of minutes and sent on the return journey. The ore will be fed to the furnaces, to the crushing and grading plant, or to the stockpiles and sinter plant, by an ore bridge and conveyor plant.

This arrangement forms part of the large development and modernisation scheme at present being carried out at Consett. A new blast furnace plant, consisting of three blast furnaces, has already been completed, together with additional coke oven capacity, new gas cleaning plant, a new central power station and other general developments. The erection of a modern high-capacity heavy slabbing and blooming mill, together with a new continuous slab and billet mill, will soon be started. Orders for these mills have been placed, the cost being approximately £5 million, and it is anticipated that they will be in operation in 1952, by which time it is hoped that the new ore discharging, handling and transporting facilities will be available. As soon as the new mills are working at Consett it is intended to reconstruct and modernise the existing heavy plate mill and include in the mill train a modern four-high stand to roll plates 120in wide, complete with new and expanded ancillary equipment.

SHUNTING LOCOMOTIVE FOR CANADA.—Ruston and Hornsby, Ltd., of Lincoln, has just supplied a Mark 165D.E. Ruston-B.T.H. 28-ton diesel-electric shunting locomotive to a factory in Toronto, Canada. This order was obtained in the face of keen American competition and, although of the makers' standard design, the locomotive incorporates certain special features necessary for Canadian operation. These features include radiator louvres controlled from the driver's cab, M.C.B. "E" type automatic couplers, and hand-rails and steps for the shunter. Arrangements have also been made for the fitting of a snowplough to the unit.

Performance of a Large Diesel Locomotive

WHAT is stated to be the most powerful diesel locomotive in Europe, the Sulzer-engined twin-unit machine of 4400 b.h.p. on the French National Railways, has now completed over 1,000,000km in revenue service. This actual mileage of 628,000 has been built up in a working period of five years eight months, or 111,000 miles a year in the haulage of 50 to 60 m.p.h. express passenger trains of 400 tons to 700 tons in weight between Paris and Lyons.

We are informed by Sulzer Bros. (London), Ltd., that over the whole of this mileage the fuel consumption has averaged 13·4 lb per mile and the lubricating oil consumption 0·30 lb. per mile. Three general and six intermediate repairs have been made on the locomotive and oil engine renewals and repairs have been surprisingly small. Each of the two pressure-charged Sulzer 2200 b.h.p. engines used on the locomotive runs at 700 r.p.m. and has twelve 12·2in by 15·4in cylinders. In general design and construction each is similar to the oil engines for locomotives now being built by Vickers Armstrong, Ltd., at Barrow, for Sulzer Bros.

Each engine fitted in the French locomotive has twin crankshafts and the four original shafts, still in use, have a maximum ovality on the crankpins of 0·04mm to 0·05mm. Only one of the original twenty-four small-end bearings has been replaced and only three of the main bearing shells. In one engine eleven top-half big-end brasses have been replaced and eight lower half brasses. In the second engine thirteen of each of the brasses have been renewed. Two connecting-rods have also been replaced.

No exhaust valves have yet been replaced and only four inlet valves have had to be renewed. In one engine all twelve original forged aluminium-alloy pistons are still in service and in the other engine ten of the original twelve pistons have been retained. Piston wear at the last intermediate overhaul—after 600,000 miles—was 0·2mm to 0·3mm, averaged from three measuring points down the piston length. Before cooling water treatment was introduced for this and other French diesel locomotives, renewal of the cylinder liners was undertaken because of corrosion on the water side, the wear then—after 499,000 miles—did not exceed 1·00mm at any point. The replacement liners showed a maximum wear of 0·04mm after 102,000 miles.

Wear in the piston ring grooves as measured after 600,000 miles varied from 0·5mm to 1·5mm for the top ring groove and from 0·2mm to 1·0mm for the grooves of the second to fifth pressure rings. The two scraper ring grooves did not show wear exceeding 0·1mm.

Each engine is fitted with two Rateau exhaust-gas turbo pressure-charging groups. In 1948 defects showed in two of these sets. As the equipment was not of a standard manufacturing size there was a long delay before the pressure-charger maker supplied the necessary new parts. As a result, the locomotive ran for 129,000 miles with one engine pressure-charged and the other naturally aspirated, the electric control system automatically regulating the engine output according to the inlet air pressure. The locomotive operated at reduced output throughout this period without complaint from the traffic department, but as might well be expected the condition of the naturally aspirated engine was not so good nor so clean as the unit which retained its pressure charging.

The locomotive weighs 225 tons in working order and its starting tractive effort of 46,500 lb can be maintained up to 25 m.p.h. On the one-hour rating the effort is 24,200 lb at 55 m.p.h. Each twelve-cylinder engine drives a 1420kW main generator through step-up gearing, increasing the speed from 700 to 840 r.p.m.

THIRD BRITISH ELECTRICAL POWER CONVENTION.—It is announced that the third British Electrical Power Convention will be held in Brighton during the week June 18 to 22, 1951, under the presidency of Sir Henry Self, Deputy Chairman (Administration), the British Electricity Authority.

Continental Engineering News

The Lille-Tournai Canal

The construction of a canal which would link Lille (France) with Tournai (Belgium) is being studied at present by the authorities and the Chambers of Commerce concerned. Part of the projected canal will include a section of the great Antwerp-Northern waterway in France, between the Seine and the Scheldt (Escaut). The length of the Lille-Tournai canal will total 14½ miles and it will be designed to accommodate 1350-ton barges. River harbours will be built both at Lille and Tournai. The harbour at Lille will cover some 125 acres, of which 110 acres will be occupied by industrial plants; the port will be provided with 2½ miles of quay walls. Works are now in progress and their completion is expected by the middle of 1951. As regards the Tournai harbour, preliminary works in connection with the construction of some 6500ft of quay walls are advancing satisfactorily. The construction of the Lille-Tournai canal will be carried out with the assistance of the Marshall Aid Plan.

Bridge Construction in Ghent (Belgium)

Monsieur Buisseret, Belgian Minister of Public Works, opened in May, 1950, the bridge called "Pont de la Barge," over the canal on the Brussels-Ostend motorway. The bridge is a steel structure of the portal frame type. The opening between the abutments amounts to 94ft. The decking has an overall width between railings of 52ft and the bridge accommodates a roadway 39ft wide and two 6½ft wide footpaths. The steel superstructure consists of ten main girders, spaced at 5·2ft centres; the footpaths are cantilevered over a distance of 2·6ft. The steelwork weighs about 130 lb per square foot of decking, i.e., about 6 lb per square foot less than in other structures of the same type existing in Ghent.

Another bridge, now under erection in Ghent also presents interesting constructional features. The bridge called "Pont du Muide" links the city with the harbour; it is an electrically-operated steel swing bridge, providing a navigation channel 65½ft wide. It provides a 21ft wide roadway and two footpaths 5·8ft each. The bridge, which replaces an ancient bridge destroyed during World War II, has been raised in order to give free passage to 300-ton barges. The superstructure rests on two concrete abutments, faced with stone and founded on piles and sheet piles.

New Sheds of the Holland-America Line at Rotterdam (Holland)

The Holland-America Line (H.A.L.) which recently celebrated its 75th anniversary, owned, before the war, at Rotterdam a series of sheds covering an area of some 950,000 square feet. Practically all these sheds were destroyed in 1940. Reconstruction work was started in June, 1945, and a new arrangement was adopted so that now all the H.A.L. facilities are concentrated on the peninsula bordered on the North by the Maas River and on the South by the Rijnhaven. The last building projects are at present nearing completion. The sheds on the Wilhelmina Embankment at present form one continuous set of buildings along a quayside extending over a distance of 2400ft, and providing berths for four ocean-going ships. The total area of this site amounts to some 350,000 square feet. On the Rijnhaven three sheds have been completed, each with a floor space of 40,000 square feet. The total length of quays here is 1600ft, with three berths for ocean-going ships. The site covers a total area of 230,000 square feet.

Aircraft Hangar at Kloten Airport, Switzerland

A large aircraft hangar was recently completed at the Swiss airport of Kloten-Zurich. The hangar covers a span of 245ft without intermediate stanchions, the roof being carried on seven steel arch ribs of the lattice truss type. The trusses rest on reinforced concrete walls, which are founded on wooden piles. The arch ribs are of non-symmetrical three hinged arch design and the hangar is provided with two large collapsible doors which entirely cover its frontage. The roof consists of thin corrugated aluminium sheets placed on wooden laths. The roof steelwork weighs about 136 tons, representing about 6 lb per square foot of covered area. The contractors were Messrs. Wartmann and Company, of Brugg; Professor F. Stüssi was the consulting engineer.

Hydro-Electric Development in Norway

A large hydro-electric scheme is at present under construction in South-Central Norway near the Oslo-Bergen railway line. This project utilises a head of about 1300ft between various high-level lakes and the Hol valley. Storage is provided by regulation of the lakes and includes the Stolsvann-Mjavann reservoir, which has a capacity of 270 million cubic yards. The first stage of the scheme involves the construction of a dam on the Vatna River, and will give an annual production of 300 million kWh of electrical energy. The second stage (the Urunda power station) will utilise the remaining water in the Stolsvann-Mjavann reservoir. The entire Hol scheme includes eight dams and is being carried out under the direction of the Oslo Municipal Electric Board.

Centenary of Sidney Gilchrist Thomas

To commemorate the Centenary of the birth of Sidney Gilchrist Thomas, the Engineers and Manufacturers' Association of Luxembourg held a series of technical lectures at Esch-sur-Alzette. These lectures were attended by Prince Jean, Grand Duke Heir of Luxembourg, and by prominent people from Britain, Belgium and France. Several of the papers presented discussed the invention of Thomas and the role it has played in the development of the iron and steel industry and agriculture of the country. A commemorative plate was fixed at the entrance of the city hall of Esch-sur-Alzette, centre of the mining and steel industry of Luxembourg.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

TENSILE TESTING OF METALS

No. 18 : 1950. This is the fourth revision of this standard, which was first published in 1904. With the exception of the definition of proof stress, the standard has not been fundamentally altered. The definition of proof stress now adopted is, however, quite different from that contained in previous issues, as it has been amended to bring it in line with the practice, current in industry, of obtaining proof stress under load. The definition is amplified to indicate methods which may be used to ascertain if the material is satisfactory when the actual value of the proof stress is not required. Section One of the standard contains the definitions of the principal terms relating to the tensile strength of materials. Section Two sets out in detail the forms of standard tensile test pieces for sheets, strips, sections, machined and unmachined rods and bars, and so on. It also includes the special test pieces for cast iron, malleable cast iron, steel tubes, cylinders and wire. Section Three deals with the standard methods of procedure for tensile testing and includes guidance on the preparation of the test piece for testing. Price 2s. 6d.

INDUSTRIAL CAPACITORS FOR CONNECTION TO POWER FREQUENCY SYSTEMS

No. 1650 Part 1 : 1950. This standard supersedes B.S. 1082, "Fixed Capacitors," in so far as that standard relates to industrial capacitors for power systems. Part I covers all impregnated paper dielectric fixed capacitors normally rated in kVAr, for connection to power frequency systems, and relates to continuously-rated capacitors for power factor correction. Part II, which is in preparation, will deal with intermittently-rated capacitors, *e.g.*, for motor starting. Capacitors such as those used for the power factor correction of individual or small groups of discharge lamps having a rating not in excess of 1kVAr are excluded from the scope of this standard. It prescribes permissible overloads, general construction details, and free tests and the appendices include methods for the determination of kVAr rating connection of capacitor, and effect of harmonics. Price 2s. 6d.

THE ENGINEER

AUGUST 11, 1950

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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THE DEFENCE PROGRAMME

How deplorable it is that now, only five years after the end of one destructive war, Britain and the other nations of the West should need again to divert beneficent productive resources to the making of munitions and equipment for war! May God send it does not mean that another war—a war even more destructive than that recently ended—draws nearer! At a first glance Britain's proposed expenditure of £3400 million in three years upon defence, as announced by the Government last week in a Memorandum addressed to the U.S.A., sounds huge, and it is, indeed, a huge and unfortunate diversion (necessary though it is) to a purpose that is no more than protective of our standard of living. Yet in reality it is by no means large by comparison with the amount of £780 million annually that this country is already devoting to defence. It is equivalent, in fact, to an annual increase of only about £350 million and to an increase of expenditure upon defence from a sum equal to less than 8 per cent of the national income to one equal to about 10 per cent. Nor does even that comparison reveal the true modesty of the proposals. It takes time to set a programme of increased expenditure in motion and it is therefore unlikely that industry will feel much of the effect before next spring. But by that time, as compared with the rate ruling last April when the last Budget was drawn up, the annual national income is likely to have increased by an amount at least comparable with the sum to be spent on defence. This year's Economic Survey estimated that during 1950 "the national product would increase by over £300 million at constant prices." Moreover, that estimate is generally believed to be too conservative. The same Survey revealed that as between 1948 and 1949 there was a rise in the gross national product of over £500 million. Something approaching that latter increase, which liberally exceeds the extra amount to be spent upon defence, seems likely to be repeated in comparing 1950 with 1949.

Circumstances demanded that the Government should formulate its new defence programme with a certain haste, and it was not therefore able to consult beforehand with industrial and labour organisations in this country. No doubt it intends to do so. For there is much to discuss and to clarify. Every industry, for instance, will want to know by how much its resources must be diverted from the manufacture of civilian goods to the making of defence equipment. It has to be decided how best to divide the new expenditure between that for the immediate equipment of the Forces and that, of a capital nature, for the expansion of manufacturing capacity. For though a war may be lost through neglecting adequately to equip the peacetime Forces, it is won by that nation which has available the greatest productive resources to keep its Forces supplied once the first shock is over. Moreover, although the rapidly increasing productive capacity of this country may well permit additional defence equipment to be manufactured without, overall, reducing the amount of goods reaching the home market it may still prove necessary in order to meet the cost to impose further taxation or to find means of economising in Government expenditure. For with present taxation taking some 40 per cent of the national income it would need an increase in the latter of some £800 million annually to provide a return to the Exchequer of the £350 million to be expended annually on defence. So large an increase in the national product cannot be confidently predicted even within the three-year term of the defence programme. On the labour side the T.U.C. will want to know what effect the programme is likely to have upon its policy of relaxing restraint upon wage claims. During the last two years, despite dollar crises and devaluation, the British people have increasingly felt the benefits that are the consequence of a rising productive capacity in the relaxation of rationing and other controls. But if the whole cost of the defence programme is to be met by Britain further relaxation of controls cannot be expected for at least twelve months, there can be little expectation of increased supplies of goods to the home market during that period, and for a time, at least, shortages may develop in the supply of particular classes of goods. In such circumstances, and if inflation is to be avoided, it would certainly be unwise to relax restraint upon wage claims. If the whole cost of the programme were met by Britain alone, there would, indeed, need to be those "real and substantial sacrifices by the British people" of which the Government's Memorandum to the United States speaks.

There is a further point. In the manufacture of defence equipment there must necessarily be a need to draw upon raw materials costing dollars. It may, too, be desirable to obtain tools and equipment from America. Furthermore, markets in sterling and other areas abroad that might reasonably have looked to Britain to supply their requirements from its increased productive capacity in 1951 may be forced instead to look across the Atlantic. Latterly, Britain's dollar account has looked more prosperous. But it certainly could not withstand the further dollar drain thus involved. Thus, the Memorandum reasonably remarks that "it would be impossible to carry out the full programme without substantial United States assistance in addition to the completion of the European Recovery Programme." Whether in the result, therefore, increased taxation will be necessary and whether a rigorous restraint upon wage claims ought to be reimposed must depend upon the scale of the assistance that America offers to this country. It is not yet known how much assistance will be offered.

GOVERNMENT AND THE ENGINEERING INDUSTRY

IN an address given at Chicago on May 9th last, the President of the American Society of Mechanical Engineers (Mr. James D. Cunningham) deplored the fact that so few technical leaders have in the past accepted even a minimum of political responsibility. He went on to say that "there are a few signs that more engineers are turning away occasionally from their professional and business lives to accept responsibilities in the educational and welfare activities of the community. If democracy is to work, professional men must be willing to accept the high responsibility of office-holding." It might be objected (erroneously, as we think) that President Cunningham in thus speaking, was setting aside the advice of Plato, who, in a passage found in the "Republic" explains why wise men refrain from meddling in the Commonwealth. If comparative aversion to political activities is (as Plato implies) a mark of the wise man, then engineers in general have stood in this category. Very few of them have been Parliamentarians and in general they cast a careless eye on large headlines in newspapers nor do they tremble at the vituperative language and malevolent threats which politicians of the baser sort are apt to hurl not only at their opponents but even at their inoffending fellow-citizens. While there is (as remarked by President Cunningham) real need for engineers to interest themselves in other than purely technical matters, it is equally desirable that professional politicians should be well informed in respect of industrial matters. For the better informed they are the less likely will they be to impede industrial progress by harmful legislation.

With the recent cooling-down of the legislative ebullience of the past few years, there has, fortunately, been a closer approach to reality amongst some politicians. For example, the Minister of Supply, Mr. Strauss, speaking recently at the luncheon of the British Internal Combustion Engine Manufacturers' Association, supported the view that the efficiency of an industry must be the responsibility of the industry. Equally worth noting were the words of Sir Vincent Tewson, Secretary of the Trades Union Congress, who, speaking on the same occasion, is reported to have remarked that "The standard of life in this country depends on the efficiency of industry. If that means breaking away from long-standing customs and traditions either in the practices of employers or employees, then it must be faced." We have, indeed, suffered enough from industrial strife and from what General Eisenhower recently described as the "economic and human deterioration," which it causes. Politics, according to Bismarck, is an art, not a science, and its practitioners, even when sincere, are apt to be guided by political enthusiasm and not by industrial experience. They tend to forget that in any technical business—indeed, in any business—only he who knows is able to lead. "Bear in mind (writes an experienced American business executive) that when the government does something for us in areas which properly are not the province of government, it is very apt to take two dollars out of our pockets, spend a dollar on red tape and the other not too efficiently in the performance of functions which we could have performed much better for seventy-five cents."

At a time when the need for the maximum effort of which the nation is capable is recognised by all save the irresponsible, it is not surprising that engineers should be concerned lest anything done in the political field may have the effect of injuring the foundations on which our technical industry has been erected. For it will not be questioned even by the fanatical that essential ingredients in the building-up of this industry have been the genius and efforts of private citizens. What has been thus built up can be brought down if the conditions which sustain it are impaired. It cannot be doubted that the chief of these conditions has been the personal initiative of the individual man. The major steps in the industrial history of Great Britain have been taken by a comparatively small number of men who had high innate resources, but little or no outside sustenance. Some of the most momentous of these advances were made by individuals who commenced life as tradesmen, such, for example, as Newcomen, Arkwright, Darby, Watt, Murdock, Crompton, Hargreaves, Wilkinson, Bramah, Trevithick, Stephenson, Maudslay and Faraday. Not all of them were enriched by their labours but each conferred incalculable benefits on his country and on mankind at large. Other of the great pioneers were from what are called the middle classes; men like Savery, Newton, Barber, Smeaton, Roebuck, Cartwright, Donkin, Joule, Stirling and Lord Kelvin. As with the tradesmen's sons, not all of these men were any the better off, in a pecuniary sense, for their efforts. They have found their incomparable emoluments in their immortality. We may mark, however, that what these men accomplished was the product of high human endowment nourished by unflagging individual effort and—slightly to paraphrase words used centuries ago by Thomas More in the "Utopia"—"What in them was by nature singular, they by learning and use had made perfect." It is futile to suppose that the peculiar talent possessed by such men can blossom on the concrete of control or persist under any conditions other than those which recognise the innate power of the individual man and provide the environment conducive to the development of the maximum capacity residing in him.

Literature

Alexander Gibb: The Story of an Engineer. By GODFREY HARRISON. London: Geoffrey Bles, Ltd., 52, Doughty Street, W.C.1. Price 15s.

COMPARED with Sir Alexander Gibb's "The Story of Telford," this is a relatively short volume to deal adequately with an extraordinarily busy and varied life, and with many facets of engineering activities. The author and publishers had to be realists when electing whether they would produce a character study, an autobiography, an engineering record, or the house journal—as is so often done these days in very attractive form—of the great team built up and presided over by the subject of this biography, Sir Alexander Gibb. The choice has been made that, tinted with shades of autobiography, the character study shall prevail. It is presented in a modern racy up-to-date style, which makes the book easy to follow, and will find for it a wider reading public, at some loss to its permanency, since the engineering difficulties overcome are not dealt with in sufficient detail to make it a book of reference for future engineers.

Considerable stress is laid on "handing down" from father to son in the engineering profession. This dynastic tendency is clearly seen, also, in the shipbuilding industry, and, too, on the engine building side, though it prevails to a much lesser extent among ship owners.

Sir Alexander is revealed in this book as a man of great courage, not only in his engineering work, as his record shows, but even more so in his personal life. He was hardest hit by fate at an age when he might well have been thinking of retiring to one of the beautiful country homes he loved so much. Firstly, in 1932, he lost an eye. Then he lost his wife, his life partner; and other partners and lifelong friends passed away in a short space of time. It is not surprising that he lost his health for a period. But despite these many blows he continued to lead his selected team into the thick of the battle to direct the forces of nature to aid mankind, and particularly in the battle against time. His sense of humour undoubtedly helped him over many a stile and supported him, even in illness and in loss.

He is also shown in the book as one who liked to apply the most modern methods to the work in hand and to use the most modern plant. He was ingenious and did not do work entrusted to him without ascertaining how the "remit" or the specification could be improved. He is shown as a hater of red tape and as a man who expressed his views with the utmost clarity.

Perhaps the feature that has endeared him most to friend and acquaintance alike is his friendliness. He genuinely likes to get to know people small and great in order to obtain their viewpoints. This characteristic no doubt accounted for the vast number of social engagements that he used to keep, no matter what the stress of work under which he might be labouring. The author refers to Sir Alexander's views on several modern social changes. He might also have ascribed to him at least lip service to a forty-hour week, but only in order to allow him to put in a concurrent forty-hour week on activities for the benefit of mankind, especially his fellow engineers and fellow Scotsmen. For he is a truly public spirited man.

The reader is led through a long engineering life from pupilage through contracting, and Army and Government service to consultancy. Mechanical engineers who believe in apprenticeship in the workshop in order that they may learn the nature of the workmen whom they will later have to lead, and the qualities of the materials they will have to handle, should applaud Gibb for deciding to be a contractor for a time. The lessons learnt paid handsome dividends in later years. His return after the 1914–18 war to consulting was no doubt partly the consequence of his great respect for Sir John Wolf Barry, his first mentor, and sprang partly from the difference in outlook among civil engineers and mechanical engineers.

Among the former considerably more respect is given to the consultant, especially in Victoria Street. In general he weighs more heavily in the counsels of the profession. But among mechanical and electrical engineers the man corresponding to some extent to the contractor, either when in charge of a factory or a power station, or as a big user, claims probably the majority of the posts of honour in his profession. So it is really no surprise to find that Gibb, having a fairly assured financial position, turned for good in 1922 to what was his first and best love—the role of the consultant. Doubtless had it been possible he would have liked to be consultant and contractor, too, but in Westminster that can't be done!

The author has revealed a number of facts about one-time well-guarded secrets such as the purpose of the "Mystery Towers" of the 1914–18 war, and the history and equipment of Rosyth dockyard. The reader can be left to investigate these items for himself.

Borrowing some of Sir Alexander's courage the author has not hesitated to dip into controversial fields concerning the origins of the Severn barrage scheme, of the hydro-electric schemes in Scotland's three most beautiful valleys—Glen Affric, Glen Cannich and Glen Strath Farrar—which make the reader wonder whether Sir Alexander has always been popular among his fellow consulting engineers in Westminster! The advance in water turbine practice, a better appreciation of how to preserve amenities, and the availability of 125,000V—and probably 250,000V—transmission lines, may eventually at a certain cost provide the nation with better schemes for harnessing tidal power. But there will be genuine regret that British engineers have not been allowed the prestige of leading the world in the building of a tidal water power project.

Turning to the more factual parts of the book, Gibb differed essentially from his forbears in the fact that few, if any, of them had travelled abroad, whereas he was ever on the move. To him the world was his operating theatre. He became, in modern language, a great dollar-earner and devoted himself in particular to the opening up of the Empire. The reader of the book will often

be well advised to get out his own pocket world atlas, since there is no map in the book itself. For despite the revival of geographical knowledge brought about by the last war, it is not easy to remember in a flash the exact location of such places as Christmas Island, Itabira, and Karabuk, to which the reader is wafted on a slick and comfortable Persian Carpet of words covering the world tours of a very remarkable, energetic, farseeing and accomplished Scot.

Photo-elasticity, Principles and Methods. By H. T. JESSOP and F. C. HARRIS. London: Cleaver-Hume Press, 42A South Audley Street, W.1. Price 28s.

PHOTO-ELASTICITY is becoming a commonplace term among engineers and is in danger of being used to imply that given the necessary apparatus all stress problems become child's play. It is not usually realised that of all the wealth of plastics that modern industry produces there is only one that nearly approaches the photo-elastic ideal and that one costs dollars! The great work of Coker and Filon almost belongs to the pre-plastic era and the modern Frocht writes with that complacent American outlook which assumes that no scientist has ever to make do with less than the best.

Messrs. Jessop and Harris have produced a book which is a boon to all those students of photo-elasticity who not only lack dollars, but are handicapped in using materials which are fifth or sixth rate. The book is a credit to authors and printer for its clarity of text and illustration. Its convenient size makes it a comfortable book to handle and read. It is a pity that in making the book self-sufficient the authors have allowed some very elementary material to creep in. The reader who needs the illustration of convex and concave lenses is unlikely to get very far with photo-elasticity. There are a few misprints and one of the appendix tables needs drastic revision. Nevertheless, such a book as this can well afford a few faults which at least have the merit of putting the serious reader on his mettle.

Railway Track. Second edition. By K. F. ANTIA, B.Sc.(Eng.). Bombay: New Book Company, Ltd., 188-190, Hornby Road. (No price quoted.)

THIS is a comprehensive treatise on the design, construction, maintenance and renewal of permanent way, with some notes on signalling and bridge maintenance as those subjects affect the permanent way man. The author, trained in England, and a Fellow of the Permanent Way Institution, is Deputy Chief Controller, Ministry of Railways, Central Standards Office, and while his book is written for Indian conditions, the treatment is sufficiently wide to make it of general interest to railway civil engineers. Complete chapters are devoted to rails, sleepers, and fishplates, with full attention to dimensional details, and his chapter on ballast and formation is of particular interest in view of the severe climatic conditions experienced in India. Further chapters deal with track stresses, layout and equipment of yards, running sheds and even with such items as ashpits and turntables, while a complete section of seven chapters is devoted to maintenance matters. The numerous diagrams are, for the most part, clear, though rather crudely drawn, and in many cases, rather small. When, among his references to ancillary subjects, the author comes to signalling he is on less sure ground, and to those unfamiliar with the practice, his description of the simple form of key interlocking widely used in India, may well prove difficult to understand in the absence of an explanatory diagram. While his sketchy and over-simplified references to automatic train control are no doubt adequate in a book intended for permanent way men rather than traffic or signalling officers, it is surprising, in view of the plethora of illustrations that have appeared in the technical press, to find him saying that the ramp of the Great Western A.T.C. system is fixed outside the track. However, in a book covering so wide a field, it would be graceless to dwell upon individual errors, and we feel sure that the book will satisfy a considerable need, and in some ways provide an Indian counterpart and complement to the handbook "British Railway Track," compiled some seven years ago by a committee of the Permanent Way Institution.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

CENTRALISED TRAFFIC CONTROL

SIR,—In the article published in your issue of July 28th, reference is made to the slow running of British goods trains. The reason is the retention of the practice of using small wagons and very lightly-loaded trains. Although it is still held that this is in order to provide an efficient, quick and cheap service, in actual practice the result is exactly the reverse.

The average load of our trains is only 150 tons, carried at an average speed of 8 m.p.h., compared with 1100 tons carried at an average speed of 23 m.p.h. in the U.S.A. Thus, British railways still continue running several little trains—running into many thousands daily—where American railways run one. Because of the heavy congestion on the running lines, our little trains have to be side-tracked at several stations *en route*—often for an hour or more—in order to allow passenger and other more important trains (milk, cattle, fish, &c.) to pass. No sooner do they begin to get up a bit of speed again than they have to slow down to be side-tracked a station or two ahead! In contrast, the heavy American train gets a clear road, and travels at a speed of 40, 50 and even more miles an hour, and runs little or no risk of being overtaken by passenger trains.

Consequently, if the present 1,000,000 outworn small wagons were replaced by less than half the number of 20-ton and 40-ton wagons (which the responsible traffic officers have often called for) the loads of trains would be more than doubled; less than half the number would be run at a greater speed; heavy savings would be made in locomotive-power, man-power and coal—enabling more passenger trains to be run, and releasing men for cleaning locomotives, carriages, stations, &c.

The larger wagons also require less than half the siding space than their equivalents in small wagons. They would cause less wear and tear on the running lines—which is not so much due to the weight of wagons, as to the 100-ton locomotives daily pounding over them hauling thousands of uneconomical little goods trains. Substantial reductions would thus be made in the upkeep of tracks.

The outworn wagons contain about 6,000,000 tons of steel—much more than sufficient to re-equip the railways with up-to-date high-capacity wagons and coaching stock. Congestion would be dispersed everywhere.

E. R. B. ROBERTS
Formerly Chief of the Wagon Control and Train-Operating Departments, Buenos Aires Great Southern Railway
St. Neots, August 2nd.

Engineering Education in the London Region

THE Regional Advisory Council has recently published a new edition of its brochure on engineering education in technical institutes and colleges and university colleges in London and the Home Counties. It has been prepared in collaboration with the engineering and Allied Employers (London District) Association, and gives general information about the various types of courses for engineering crafts, National Certificates, &c., for students from the time they leave school. An outline is given of facilities available for students who are qualified to follow courses for university degrees and research, together with a list of the colleges concerned and the courses offered. It is pointed out in the publication that engineering education in London and the Home Counties includes so many different courses that it is bound to be a little bewildering to many in the industry whose experience has not brought them into touch with the differing kinds of technical education for engineers in the region. The outline of these facilities given is intended to give some help to those in industry whose duties include the giving of advice to young employees on the type of further education they can most profitably follow. The publication can be obtained from the offices of the Regional Advisory Council, at 20, Fitzroy Square, London, W.1

The Model Engineer Exhibition

ON Wednesday last, August 9th, the jubilee Model Engineer Exhibition was opened in London at the New Horticultural Hall, Westminster, S.W.1, and it will be open daily to the public until Saturday, August 19th. This exhibition, which for so many years has been popular with engineers and model makers, young and old alike, is as well arranged and organised as ever. As might well be expected, the models are both interesting and varied and show the high degree of enthusiasm and initiative for which the entries at this exhibition have always been known. A surprising thing about the exhibition which the regular visitor must feel every year is the way the model maker finds so many varied and unexpected subjects for his particular craft. The same high standard of craftsmanship is shown in all the models, whether they have been made with hand tools on a kitchen table or in an elaborately equipped workshop. This year the arena for demonstrating models in action has been replaced by a demonstration section, in which the actual making of models is shown by experts. Here visitors are able to see and question craftsmen engaged in the different machining and other processes involved in model making. The demonstrations also include wood turning, smithing, welding, glass blowing, puppet theatre working, &c. In addition to the many ship, locomotive, aircraft and motor vehicle models there is a 500 c.c. motor-car suitable for construction by the "home craftsman." This vehicle, it is stated, can be built for about £100, and is capable of speeds up to 110 m.p.h.

BOOKS RECEIVED

Handbook of Rigging. By W. E. Rossnagel. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 40s. 6d.

Mechanik Deformierbarer Körper. By Professor Dr.-Ing. Friedrich Tölke. Berlin: Springer-Verlag, Reichpietschufer, 20. Price Dmk 45.

Arc Welders' Tables and Data. Edited by A. J. Coker. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 5s.

Practical Management and Works Relations. By A. C. Whitehead. London: Emmott and Co., Ltd., 21, Bedford Street, Strand, W.C.2. Price 3s. 6d.

Elementary Physics for Technical Students. By L. S. Powell. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 6s. 6d.

Simplified Measurement of Gas Flow with Sharp Edged Orifices

By J. G. WITHERS, B.Sc., A.Inst.P., A.M.I.Mech.E.

MEASUREMENTS of gas flow are required in many investigations of the behaviour of reciprocating and gas turbine engines. The author has found that engineers make frequent mistakes in the calculations because conversion of units in the formulæ is usually necessary, and the method of presentation in the well-known works of reference tends to be rather involved.

Sharp-edged orifices are considered in most cases preferable to nozzles or venturis on account of the ease with which they can be made and checked dimensionally. This note has as its object the presentation of all the necessary information in the simplest possible form, employing the prevalent units of engineering measurement. The simplifications given in some instances increase the restrictions on the design and lay-out of the orifice and associated pipework, and where it is found impracticable to adhere to the recommendations given it is suggested that British Standard Code 1042 : 1943 or Spiers' "Technical Data on Fuel" should be consulted. No loss of accuracy will, however, result from the simplifications.

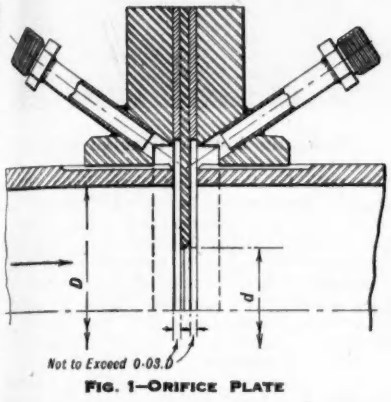


FIG. 1—ORIFICE PLATE

GENERAL ARRANGEMENT OF ORIFICE

The orifice plate (Fig. 1) should be sufficiently thick to avoid buckling and should be of a material which is not corroded by the gas used. In most cases a suitable thickness is $\frac{1}{8}$in, but it should not exceed one-tenth of the pipe diameter.

The orifice should be machined all over and be carefully bored to the correct diameter. Its upstream edge should be perfectly square and free from burrs, and the use of abrasive cloth should be avoided in the finishing operation. It may even be necessary to lap the upstream face of the orifice plate to ensure a perfectly sharp corner. The downstream edge should be bevelled at 45 deg. to give an orifice thickness of not more than $\frac{1}{32}$in, and, for small orifices, not exceeding one-eighth of the orifice diameter.

The orifice plate can be clamped between flanges which are drilled to enable the differential pressure to be measured, and the holes should communicate with the pipe at the faces of the orifice plate (corner taps). The ends of the pipe should be machined square and be free from burrs. If the ends of the pipes are made level with the faces of the flanges, the end clearance can be controlled by the joint thickness. Concentricity of the

TABLE I.—*Values of E*

d/D	0	0·01	0·02	0·03	0·04	0·05	0·06	0·07	0·08	0·09
0·1	0·600	0·600	0·600	0·600	0·600	0·600	0·600	0·600	0·600	0·600
0·2	0·601	0·601	0·601	0·601	0·601	0·601	0·601	0·602	0·602	0·602
0·3	0·603	0·603	0·603	0·604	0·604	0·605	0·605	0·606	0·606	0·607
0·4	0·608	0·609	0·610	0·611	0·612	0·613	0·614	0·615	0·617	0·618
0·5	0·620	0·621	0·623	0·625	0·627	0·630	0·632	0·634	0·637	0·640

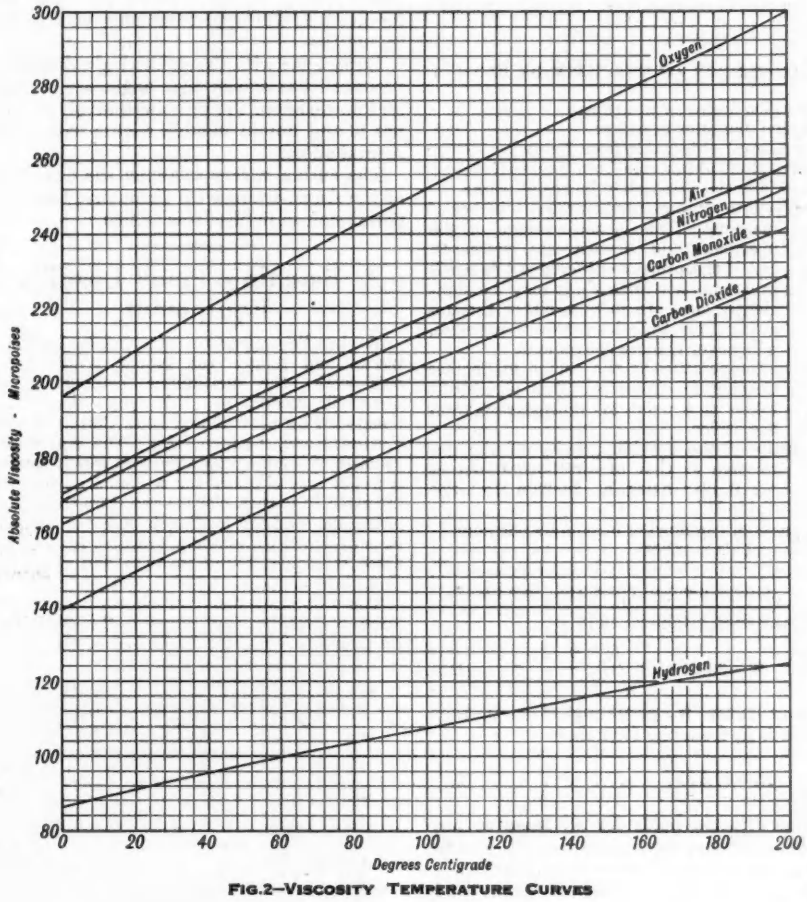


FIG. 2—VISCOSITY TEMPERATURE CURVES

TABLE II—*Correction Factor M*
The tabulated figures are Reynolds number in orifice divided by 1000.

d/D / M	Below 0·20	Over 0·20 to 0·30	Over 0·30 to 0·35	Over 0·35 to 0·40	Over 0·40 to 0·45	Over 0·45 to 0·50	Over 0·50 to 0·55	Over 0·55 to 0·60
0·985	Over 1000	Over 1000	—	—	—	—	—	—
0·990	490 –1000	600 –1000	Over 1000	Over 1000	—	—	—	—
0·995	120 – 440	160 – 600	260 –1000	450 –1000	Over 1000	Over 1000	Over 2000	Over 2000
1·000	63 – 120	76 – 160	95 – 260	150 – 450	250 –1000	400 –1000	600 –2000	600 –2000
1·005	44 – 63	55 – 76	70 – 95	92 – 150	110 – 250	140 – 400	200 – 600	200 – 600
1·010	33 – 44	40 – 55	51 – 70	68 – 92	82 – 110	100 – 140	120 – 200	120 – 200
1·015	23 – 33	30 – 40	38 – 51	50 – 68	62 – 82	77 – 100	90 – 120	95 – 120
1·020	17 – 23	21 – 30	28 – 38	37 – 50	46 – 62	59 – 77	68 – 90	76 – 95
1·025	12 – 17	15 – 21	21 – 28	26 – 37	35 – 46	45 – 59	53 – 68	60 – 76
1·030	9 – 12	11 – 15	16 – 21	20 – 26	26 – 35	35 – 45	41 – 53	46 – 60
1·035	6 – 9	8 – 11	12 – 16	16 – 20	20 – 26	26 – 35	32 – 41	38 – 46
1·040	4 – 6	6 – 8	8 – 12	12 – 16	16 – 20	20 – 26	24 – 32	29 – 38
1·045	—	4 – 6	6 – 8	9 – 12	13 – 16	16 – 20	19 – 24	23 – 29
1·050	—	—	5 – 6	7 – 9	11 – 13	13 – 16	16 – 19	18 – 23
1·055	—	—	—	6 – 7	9 – 11	11 – 13	13 – 16	15 – 18
1·060	—	—	—	5 – 6	7 – 9	10 – 11	11 – 13	13 – 15
1·065	—	—	—	—	—	—	10 – 11	11 – 13
1·070	—	—	—	—	—	—	—	10 – 11

orifice in assembly is ensured by making the orifice plate the same outside diameter as the flanges.

It is recommended that the orifice diameter should not exceed 0·6 of the pipe diameter, and it is advantageous for this fraction to be as small as possible, although it will seldom be convenient to make it less than 0·4. At least twenty-five pipe diameters of straight smooth-walled pipe upstream of the orifice and at least three pipe diameters downstream should be allowed.

Large errors are introduced by pulsations in the flow and pulsations should be damped out by suitable surge chambers and throttling points. Conditions are usually satisfactory if an undamped water gauge measuring the differential pressure shows no visible oscillation of the meniscus.

The diameter of the orifice required for a given flow range can be calculated from equation (1) in the next section, assuming $M=1$ and $E=0·6$. A suitable value for the differential pressure under maximum flow conditions is 36in of water, and a single leg manometer is recommended for the measurement.

Calculation of the Rate of Flow

d=orifice diameter in inches.
D=pipe diameter in inches.
E=constant obtainable from Table I.
M=Constant obtainable from Table II.
h=differential pressure in inches of water.
P_f=absolute pressure at the orifice in inches of mercury. This is the average of the upstream and downstream pressures, but if the pressure difference h is small in comparison with P_f, it may be sufficiently accurate to take either the upstream or the downstream pressure, whichever is more convenient.
T_f=the temperature at the orifice in degrees Centigrade absolute. This should be taken at a point $3D$ downstream from the orifice.
S=ratio of the specific gravity of the gas relative to that of air, both taken at S.T.P. (288·5 deg. K., 29·92in Hg.). See Table III.
W=mass of gas flowing in pounds per hour.
R_e=Reynolds number.
η=coefficient of viscosity in micropoises at T_f (independent of pressure). See Fig. 2.

It may then be shown that

$$W=308\,EMd^2\sqrt{\frac{hP_fS}{T_f}} \quad . \quad . \quad . \quad (1)$$

First calculate W, assuming $M=1·0$, then calculate R_e from the formula

$$R_e=63{,}300\frac{W}{d\eta} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

(This formula holds for all gases at any temperature or pressure, provided the value of η appropriate to T_f is used (see Fig. 2)).

Then obtain M from Table II, from which the corrected value of W may be obtained.

Volumetric flows at any temperature T (degrees Centigrade absolute) and pressure P (inches of mercury absolute) may be obtained from the formula

$$Q=0·02265\frac{WT}{SP} \text{ cubic feet per minute} \quad . \quad (3)$$

Table III.—*Values of Specific Gravity Relative to Air*
(288·5 deg. K., 29·92in Hg.)

Gas	S
Air	1·000
Oxygen	1·105
Nitrogen	0·967
Hydrogen	0·0695
Carbon monoxide	0·968
Carbon dioxide	1·528

The accuracy to be expected from measurements calculated as described above is within ±2 per cent, provided h does not exceed 20 per cent of the upstream absolute pressure.

Correction for Humidity in the Measurement of Moist Air Flow

Since the mass flow is proportional to the square root of the relative density, as shown in equation (1), a correction will be required for the change in density resulting from the presence of water vapour; since the density of water vapour is only approximately 0·62 that of air, the indicated mass gas flow, assuming $S=1$, will be higher than the true value.

Let a be the weight in pounds of water associated with 1 lb of dry air. To obtain true moist air mass flow multiply the indicated gas mass flow by $1-0·3a$. To obtain true dry air mass flow multiply the indicated gas mass flow by $1-1·3a$.

The approximations made in the above corrections give errors of less than 1 per cent for values of a up to 0·07, equivalent to saturation at 45 deg. Cent., and thus well cover all atmospheric humidity conditions. Much smaller errors than 1 per cent are involved in the approximations with lower humidities.

Experience with the method of calculation described has shown that engineers, having no knowledge of the principles involved, can use it and obtain reliable results with little mental effort.

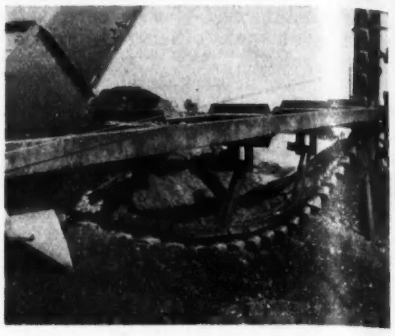
The author wishes to thank the chairman of the Anglo-Iranian Oil Company, Ltd., for permission to publish this article.

A Batching Plant Loading Equipment

To handle aggregates at concrete batching plants and reduce the labour required for this work, the continuous loading equipment illustrated on this page has been developed by Blaw-Knox, Ltd., Clifton House, Euston Road, London, N.1. The equipment consists of a triangular structure which acts as a guide and support for a chain of buckets arranged to gather, elevate and drop the aggregates into a chute leading to a batch hopper. It is designed to handle aggregates from up to three stockpiles round its base and discharge them into hoppers set 19ft above ground level.

The unit has a heavy cruciform base with a large central bearing carrying the swivelling mast which forms the backbone of the structure. The power unit for the bucket line is mounted near the top of the mast, and can be either a 5·5 h.p., 1800 r.p.m., petrol engine, a 5 h.p., 1500 r.p.m. oil engine, or an electric motor. Drive is transmitted through chains to give a bucket line speed of 250ft per minute, and a capacity during continuous operation of from 65 to 70 cubic yards an hour.

Projecting from the lower end of the mast is a rigid fabricated boom which is coupled at its outer end to an inclined bucket support member leading up to the structure at the top of the mast. The two main members of the inclined bucket support are spaced to form a guide path for the bucket chain links. The complete structure can be swivelled through an arc of 200 deg. to traverse the lower boom over three stockpiles at the base of the unit. On the boom the bucket line is tensioned and held in contact with the stockpile by a series of chain guide-rollers carried on long links, supported by brackets depending from the boom members, as shown in one of our illustrations. This bucket line has an effective digging length of 14ft. The boom can be raised and lowered by means of a hand winch, and its radius can be varied from 19ft 9in to 25ft 6in. In the equipment now being made the hand winch is replaced by a hydraulic jacking system, through which the lower boom can be raised to clear and pass over the centre stockpile when required.



Boom and Bucket Loading Line

When the equipment is being used to feed a batching plant with three aggregate hoppers, the discharge chute at the top of the mast can be swivelled to drop the material into the appropriate hopper section for the grade of material being elevated. The loader is built up from easily dismantled unit sub-assemblies to facilitate its transport and erection on working sites.

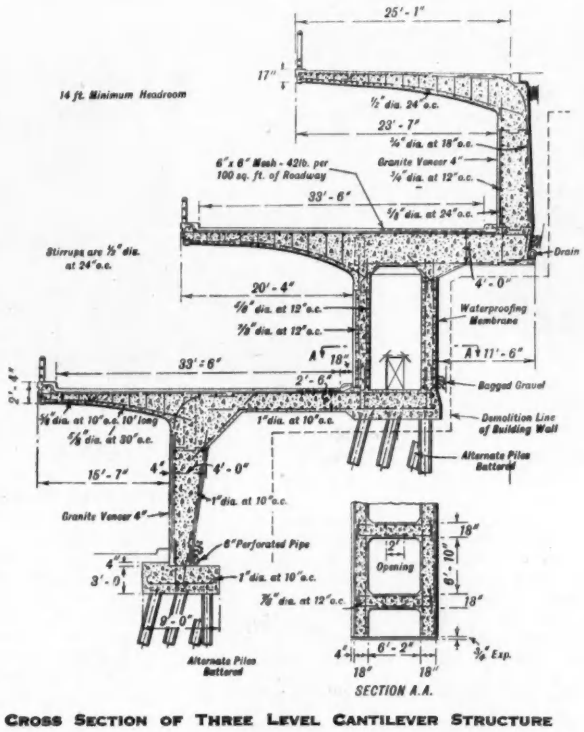
Loading Equipment in Operation

The Brooklyn-Queens Highway

THE Brooklyn Queens expressway, which is at present under construction in New York City, is carried by an unusual three-level cantilever structure built into the hillside. When completed, it will provide three traffic lanes in each direction and a promenade on the top deck. Successive levels of the expressway are set back to provide increased light and air, as shown in the accompanying illustration, but this provision requires less than 50ft of additional width.

As may be seen from the diagram, the highway structure is supported by piles at two levels, some of the piles being inclined to take horizontal thrust. The L-shaped section of the structure between the two rows of piling is a rigid frame, carrying a double wall, with diaphragms at intervals, which supports the roadway at the intermediate level. The pedestrian cantilever at the top, and the vertical wall below it, form structurally a single cranked cantilever. A maximum concrete stress of 650 lb per square inch was allowed in the design of this structure.

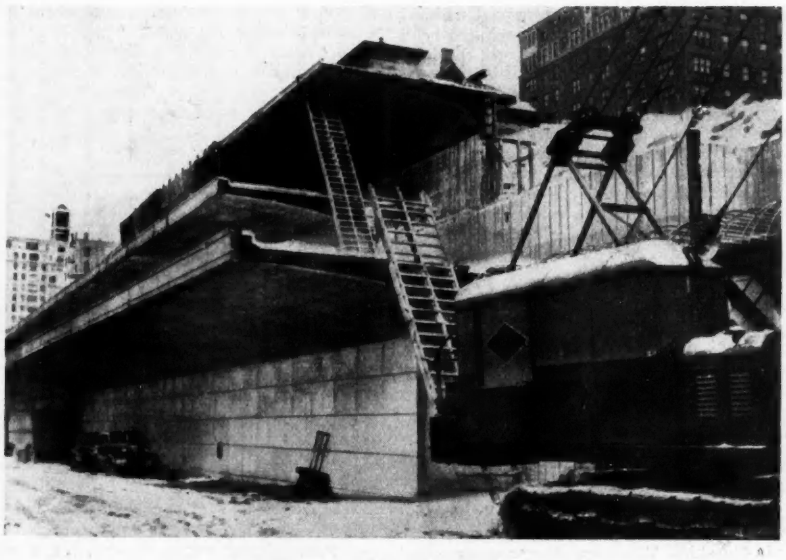
Sound-deadening provisions included designing the undersides of the cantilevers as quadrants of ellipses instead of as parabolic shapes. The walls along the roadways are faced with granite veneer, and illumination provided from lights set in the concrete soffit.



CROSS SECTION OF THREE LEVEL CANTILEVER STRUCTURE

In the Brooklyn Heights section of the highway site three-storey dock buildings were separated by a street 50ft wide from a bluff which rises steeply to a height of about 60ft. In the past buildings built on the bluff had their rear walls and roofs arched to support the hill at the rear and an earth fill on the top. Where possible, these old arches have been left in place to help retain the embankment and to support existing structures on Columbia Heights during construction. However, some of the structures on the upper level had to be demolished and others had to be underpinned.

Originally it was intended to use cast-in-place concrete piles, but conditions made it necessary to change to steel H-section piles, mainly 14in, 102 lb sections, designed to carry 40-ton loads. Piles on the lower level are between 25ft and 30ft long, while those higher on the hillside are about 35ft long. Following the driving of piles at the lower level, the footing and wall were then constructed and backfilled to prevent earth movement. To drive piles at the lower level over the full-length reinforcing bars, a special driver was rigged to ride on a gantry frame on rails at the street level, and on a single rail at the higher level, thus bridging the reinforcing.



HIGHWAY UNDER CONSTRUCTION

The cantilever section of the roadway was built with travelling steel shutter units, each 60ft long, to match expansion joints, and moving on rails on the roadway below. These units were lifted into position with hydraulic jacks. Different widths and shapes of cantilever made three sets of forms necessary. The form surface was a ¼in plate supported by 3in by 4in by ¼in angles spanning 5ft and at spacings varying with the load. The edge of the 4in leg of each angle was welded to the plate, thus forming a 4in channel with a 3in flange. The supporting frame was rigidly braced to take the load of uneven concrete depth and tied to the wall by anchors which had been cast into the wall when it was concreted.

Heavy beams and angles were used to support the reinforcing steel and to avoid damaging the underside of the cantilever slab. Steel angle hangers were placed to carry the lower steel from the rods above, instead of supporting it on conventional small concrete blocks resting on the formwork.

The Ames Aeronautical Laboratory, America

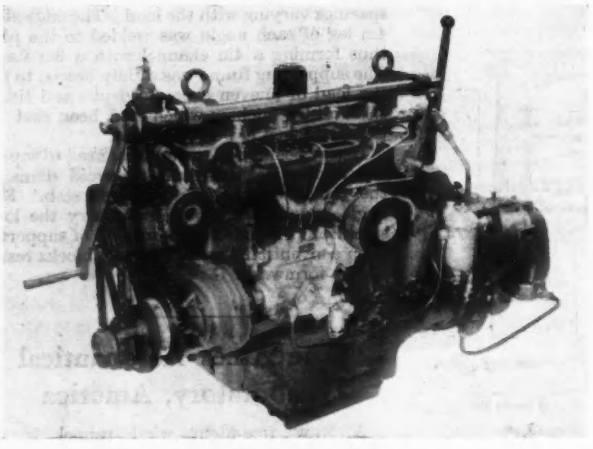
A NEW free-flight wind tunnel is now being used at the Ames Aeronautical Laboratories, at Moffett Field, California, which are operated by the National Advisory Committee for Aeronautics. The speeds of the models in the new wind tunnel are achieved by generating an airstream two or three times the speed of sound. Into the face of this stream a model is fired by a launching gun and is caught in a steel cylinder packed with cotton waste and backed by wood and steel. The guns in use range from ·22 calibre to 3in. A speed of 6000 m.p.h. has been attained by a model launched from a ·22 calibre sporting rifle, and it is expected that improved equipment will facilitate speeds of more than 11,000 m.p.h. Because of the relatively high density of air in the wind tunnel, a 6in model tested at a speed of about 5500 m.p.h. provides data corresponding to that obtained on a 50ft missile, as large as a German V-2 missile, flying at the same speed at a height of 100,000ft. A conventional wind tunnel would require a model more than 10ft long to obtain equivalent results.

Techniques similar to those used in aeroballistic research are employed to study the characteristics of the missile model as it advances through the test section of the wind tunnel. A flight history of the model is recorded in shadowgraph images and chronograph readings with the aid of various conventional means. Distances can be measured to within a few thousandths of an inch and time measurements are said to be accurate to a tenth of a microsecond. The latter is an interval during which light covers only 100ft. The new tunnel is intended to provide data for use in the design of missiles to operate at altitudes of 12 to 28 miles. Accordingly, the pressure in the test section of the 10in by 14in tunnel can be reduced to one-thousandth of an atmosphere, equivalent to the pressure found at an altitude of 30 miles. Under such conditions, the speed attained is seven times the velocity of sound.

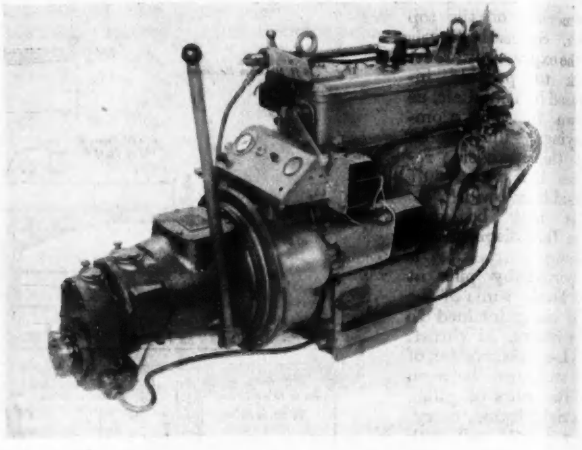
EFFECT OF SULPHURIC ACID ON MONEL AND OTHER HIGH NICKEL ALLOYS.—A new publication of Henry Wiggin and Co., Ltd., of Birmingham, deals with the effects of temperature, aeration, agitation and acid concentration on the corrosion-resistance of Monel, nickel, "Ni-Resist," "Iconel," and other nickel-chromium alloys, when attacked by straight sulphuric acid solution. The effect of reactions in which sulphuric acid is mixed in varying amounts with other chemicals is not readily predicted and numerous corrosion tests have been made in plant under actual operating conditions. The publication, which is obtainable free of charge from the company, gives detailed reports on these tests.

Two Small Marine Engines

TWO new marine units of low power are being made by the firm of David Brown, Tractors, Ltd. One is a petrol/paraffin engine (Type MK 4/3) and the other a diesel model (Type MD/4), both of which have been approved by Lloyd's Register of Shipping.



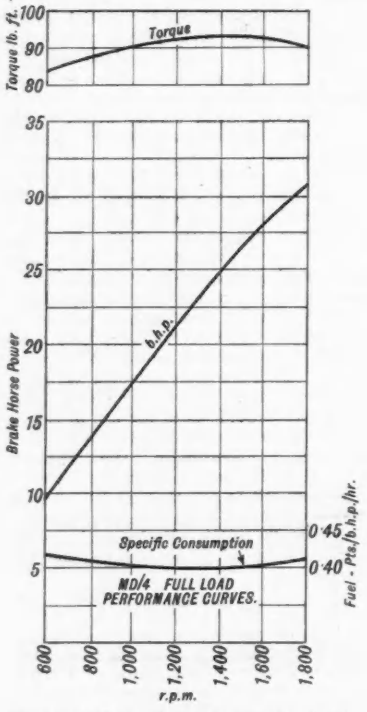
DIESEL ENGINE MD/4



PETROL/PARAFFIN ENGINE MK4/3

Diesel Unit

The diesel model, which can be seen in the accompanying illustration, is compact, with a high power/weight ratio, and has been designed for reliability and economic running, the engine being quiet over the whole speed range, and when idling there is no "diesel knock." It is an overhead-valve, four-stroke engine and has four cylinders and develops 25 b.h.p. at 1400 r.p.m., the corresponding torque being 94 lb ft, and 31 b.h.p. at 1800 r.p.m. The cylinders have a bore of 3½in by 4in stroke, the compression ratio being 15·8 to 1, and the order of firing is one, two, four, three. A reverse gear is fitted, and the engine is arranged for direct drive, but provision has been made for adding, as an alternative, a reduction gearbox, there being two models available having reduction ratios of 2 to 1 or 3 to 1. Starting is by hand or by a 12V electric motor combined with the use of a decompressor. The starter batteries are charged by a 12V dynamo, belt-driven from the front end of the crankshaft. Six mounting feet are provided to suit 3in bearers having an overall width of 24in. The engine has a length of 4ft 9 $\frac{5}{16}$ in, a width of 23½in, a height of 35 $\frac{5}{16}$ in, and the weight, excluding batteries, is 1120 lb.



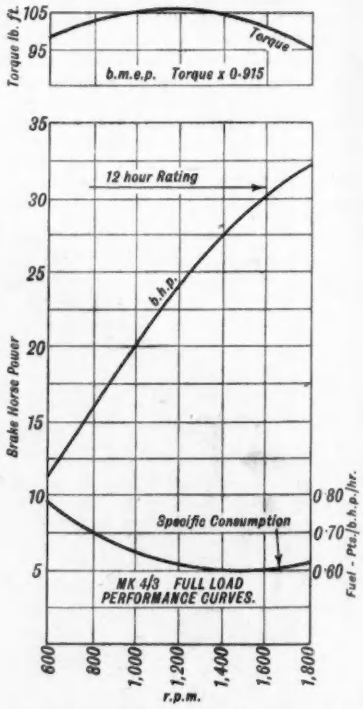
PERFORMANCE CURVES—DIESEL UNIT

Materials and Design

The cylinder block and crankcase is a monobloc casting in high-duty nickel-chrome cast iron, the crankcase having separate main bearing caps secured to it by studs; the cylinder block has bearings for the camshaft machined in it. The oil gallery is integral with the casting, and inspection doors are arranged on the tappet side. A monobloc nickel-chrome casting, incorporating a water distributing tube, a rocker shaft and support bearings forms the cylinder head, which can be removed without disturbing the timing. Set in the cylinder head and tangentially to the cylinder bore, the inlet and exhaust ports set up a swirl, the direction of which assists in ejecting the exhaust gases. A cast iron cover, provided with a breather, encloses the rockers. Close grained cast iron removable wet liners are provided and are sealed at the top by a copper gasket nipped between the locating flange and the cylinder block, and at the bottom by two rubber rings. The sump, with an oil capacity of three gallons, is of cast iron and the water-cooled exhaust manifold is a one-piece iron casting.

The reverse unit, of planetary bevel gear design, with fixed planet carriers, runs in oil and a single lever controls the ahead and astern ferodo-lined clutch plates which are dry. The reduction gear having shafts running on ball bearings and spur gears, is lubricated by a splash feed from oil in the bottom of the casing, which is water-cooled. Cast in silicon alloy, the pistons have a toroidal combustion chamber machined in the crown and offset from the piston centre; there are three compression rings above the gudgeon pin, which is fully floating between circlip retainers, and there is a scraper ring in the skirt. The connecting-rods are steel stampings with replaceable thin shell pattern copper-lead steel-backed big end bearings. The cast Monikrom camshaft, driven by single helical steel and cast iron gears is splash lubricated, and has end thrust taken up by a thrust washer and ground cam profiles and bearings. Drilled for pressure lubrication to main and big end bearings and having integral balance weights, the forged nickel-chrome-molybdenum steel crankshaft has all journals hardened by the Tocco electrical induction method and is supported in three bearings of replaceable steel-backed shells of copper-lead in the lower halves and white metal in the upper halves. The centre bearing takes the end thrust and an extension of the crankshaft at the front end takes the auxiliary drive. There is a nickel-chrome cast iron flywheel with a steel toothed starter ring. Silicon-chrome steel valves, working in nickel cast iron guides, are operated through hollow chilled cast iron tappets, steel hollow push rods and rockers and single valve springs.

A C.A.V. pump injects fuel through four-hole nozzles dowelled in the holders which are flange-bolted to the cylinder head, and is supplied via a filter, by a plunger feed pump, cam-operated from the injection pump camshaft. A pneumatic governor, mounted on the injection pump, operates the pump control rod and a device on the pump provides an increased quantity of fuel when starting. Speed control consists of a butterfly valve within a venturi located in the air intake manifold, which is connected to the vacuum part of the governor.



PERFORMANCE CURVES—PETROL UNIT

Pressure lubrication is by means of a gear pattern oil pump, and a hand operated suction pump drains the oil sump. Cooling is on the open water system, thermostatically-controlled, and the cold water supply to the cylinder head and block is by-passed to the suction side of the pump during warming up.

Petrol/Paraffin Unit

Our illustration shows the overhead valve four-stroke, petrol/paraffin engine, which has four cylinders of 3⅛in bore by 4in stroke and a compression ratio of 4·7 to 1. The power output is 27 b.h.p. at 1400 r.p.m. and 32 b.h.p. at 1800 r.p.m., and the maximum torque of 105·5 lb ft is developed at 1400 r.p.m., while the speed range is 600 r.p.m. to 1800 r.p.m. A reverse gear is fitted and the reduction gear supplied can have a ratio of 2 to 1 or 3 to1, as required. Starting is by hand or by a 6V starter, and there is a belt-driven 6V dynamo. The length of the engine is 4ft 4in, the width 21½in, the height 35⅞in and the weight is 1080 lb, excluding batteries.

Materials and Design

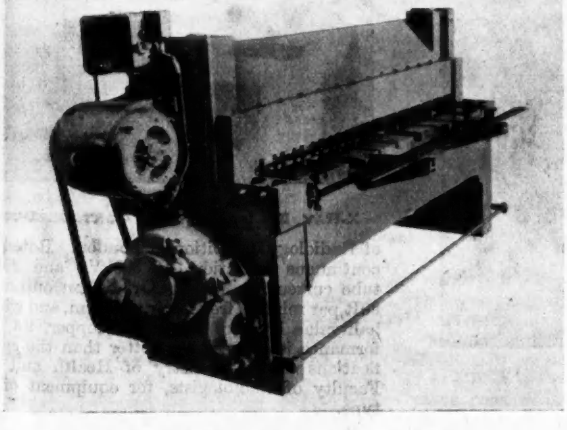
Although each item was designed specifically for this engine, the materials used are, in many instances, the same as for the diesel unit, and the description of many parts is generally similar. This applies to the cylinder block and crankcase, cylinder head, cylinder liners, sump, exhaust manifold, camshaft, reverse unit, reduction gear, flywheel, valves and operating gear, lubrication and cooling systems.

Cast iron tin-plated pistons having a cavity crown are used and there are two compression rings and one slotted oil control ring, the gudgeon pin floating in bronze bushes. The big end bearings of the connecting-rods are of the replaceable steel-backed white metal thin shell pattern and the crankshaft, a heat-treated carbon steel forging, is supported in three main bearings of steel-backed, white metal design. An up-draught, balanced carburettor is fitted, together with an air cleaner.

A 72in Squaring Shear

To the range of sheet metal working machines made by F. J. Edwards, Ltd., 359, Euston Road, London, N.W.1, has been added a new precision squaring shear for mild steel sheet up to 10 gauge and 72in long. This machine is of heavy construction to reduce deflection when cutting to a minimum, and the low rake or shear angle of the upper blade reduces the tendency to twist on narrow strip work.

The machine, which is illustrated below, is driven by a 5 h.p. motor through vee-belts, a flywheel and a worm and wheel reduction unit. A non-repeat multi-jaw clutch is actuated by a latch box of special design and by movement of a small lever the machine can be set for single stroke or continuous operation at sixty strokes a minute. A treadle shaft running the full length of the machine enables the operator to engage the clutch from the most convenient position. The weight of the top beam is counterbalanced by springs within the side frames to give a smooth shearing action.



Squaring Shear from Driving End

The pitman links are bronze bushed for the eccentric and cross head pins. The crankshaft, situated below the lower blade beam, is completely covered by a sheet steel chute for the cut off material.

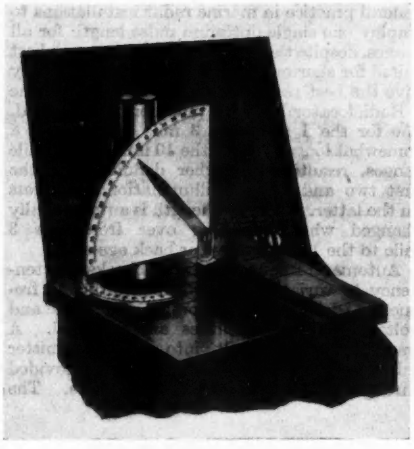
A series of hold-down plungers are spaced from end to end of the machine on 6in centres. Light or heavy gauge sheets can be clamped by these plungers without any adjustment, or short pieces of different gauges can be sheared side by side at the same time.

A front gauge with a range of 22in can be set parallel to the blades or at an angle, and extension arms are furnished which carry both the sheet and the front gauge beyond the width of the table. A side gauge is fitted to the blade table for use when cutting at right angles to the gauging angle of the sheet and a back gauge with a 24in range is supplied.

High alloy shear blades of ample section are ground with four cutting edges to make them reversible and avoid necessity for frequent regrinds. These blades are of a high alloy steel suitable for cutting stainless steel up to 16 S.W.G.

A Cutting Tool Protractor

A new piece of equipment for the rapid and accurate measurement of cutting tool angles has been developed by W. H. Marley and Co., Ltd., 105, High Road, London, N.11. This instrument, as can be seen in the illustration above, consists essentially of a surface plate at one corner of which is a pillar assembly incorporating two protractors, one in a vertical and one in a horizontal plane.



Cutting Tool Protractor

The pillar can be rotated on its centre, and the protractor at its foot indicates the arc through which it has turned in respect to lines engraved on the plate. An indent plunger at the foot of the pillar locates it in the zero position. The second protractor is mounted on a bracket on the pillar. This bracket is located on the pillar by a groove and can be moved vertically up and down and locked in any required position.

Pivotally mounted at the centre of the protractor is an indicating arm with a downwards projecting foot, the bottom and sides of which can be registered on the tool face to be gauged, by movement of the protractor up or down the pillar.

The instrument has been designed primarily for the measurement of turning tool angles, but it can be used for determining any angle relative to a given reference plane. Side rake angles are measured in a plane at right angles to the shank of a tool. For such measurement, the tool is placed on the surface plate with its shank in line with the parallel lines running from the front to the rear of the plate. When the horizontal or lower edge of the foot of the pillar protractor arm is lowered into contact with the top of the cutting face, the angle can be read directly from the scale.

Relief and clearance angles are measured by lowering the pillar protractor until the vertical edge or side of the protractor foot registers against the face in question. Back rake, approach, trail and maximum rake angles can be measured with equal facility by positioning the two protractors and moving the pillar protractor up and down. The table is 6½in square and the instrument can be used to measure tool sections up to 2in.

Technical Reports

Interim Report of the Departmental Committee on the Deterioration of Cast Iron and Spun Iron Pipes. London: H.M. Stationery Office. Price 3s. 6d.—In recent years evidence has accumulated of the rapid external corrosion of cast iron and spun iron pipes used for water supply, especially those laid in clay subsoils containing sulphates. In view of the large number of bursts and premature replacement of mains which had resulted, the Minister of Health set up a Departmental Committee in December, 1948, to investigate the matter.

This Committee has now issued an interim report which has just been published. It covers the scientific and technical aspects of corrosion, deals with the extent of the problem and its implications, and suggests measures for protecting pipes in areas where the soil formation is known to be corrosive.

Forest Products Research, 1939–1947. D.S.I.R. London: H.M. Stationery Office. Price 3s. 6d.—This is the first post-war report of the Forest Products Research Board, and it covers both the war years and the years 1946 and 1947. It gives a brief review of the activities of the Forest Products Research Laboratory during the period of hostilities, followed by a reference to proposals for post-war development of the Laboratory.

The reports for the years 1946 and 1947 include descriptions in greater detail of the work carried out by the Laboratory during this period under the headings of Wood Structure, Physics, Seasoning, Wood Bending, Timber Mechanics, Composite Wood, Woodworking, Wood Preservation, Mycology, Chemistry and Entomology. Owing to the acute shortage of timber, and the importance at the present time of the search for substitutes for the timbers from hard currency sources, a programme of tests on some hitherto neglected secondary timbers growing within the Empire has been embarked upon.

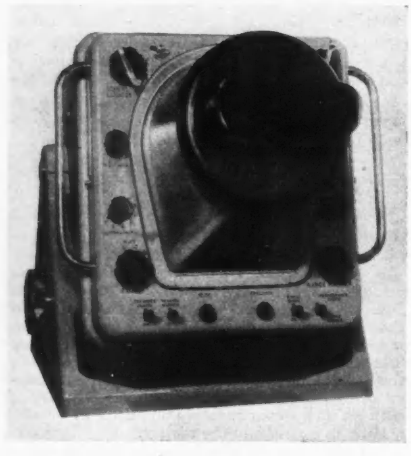
An account is given of the development of the work on composite wood products (e.g., plywood, improved wood and glues), which began in 1935, with a description of the new plywood laboratory for experimental work on timber, machinery and manufacturing processes.

Statistics of the United Kingdom Airways' Corporations.—Operating and traffic statistics for the United Kingdom Airways Corporations for the first quarter of 1950 have now been released by the Ministry of Civil Aviation, and a provisional assessment can be made of traffic results on the Corporations' scheduled services for the year April, 1949, to March, 1950. These provisional statistics show that during the year the Corporations carried approximately 900,000 passengers, 10,300 tons of freight and 5500 tons of mail. The passenger figures are 26 per cent and the freight and mail figures 20 per cent higher than those for the year ended March, 1949. Passenger-miles flown totalled 634 million, an increase of 12 per cent; freight ton-miles rose by 11 per cent to 18 million, and mail ton-miles flown at 11 million were 7 per cent higher than in the previous year. The Corporations offered a capacity of 152 million ton-miles, an increase of 19 per cent on the previous year. Revenue load ton-miles totalled 87 million, an increase of 10 per cent. The overall revenue load factor fell from 60·9 to 57·0 per cent.

An Improved Marine Radar Equipment

A NEW marine radar equipment, the "Radiolocator IV," introduced by the Marconi International Marine Communication Company, Ltd., Chelmsford, is designed for detecting and locating suitable targets, such as high land masses, at distances as great as forty miles, an improvement on the range so far achieved by commercial marine radar installations.

The "Radiolocator IV" is very much more compact than the previous models, but it is by no means a "baby" radar, and it embodies the experience gained from its predecessors. All the principal advantages of the well-known "Radiolocator"—range rings, the variable range marker, bearing indicator, clutter and sensitivity controls, and open-centre device for close-range observation—have been retained, and many useful improvements have also been incorporated, apart from the great increase in range.



"RADIOLOCATOR IV" MAIN DISPLAY UNIT

Main and Remote Display Units

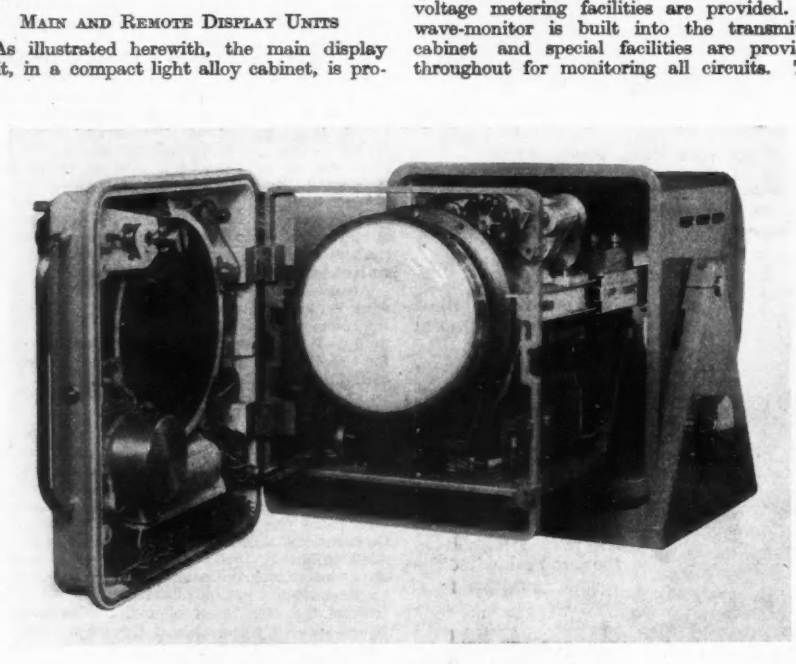
As illustrated herewith, the main display unit, in a compact light alloy cabinet, is provided with a trunnion mounting which permits fitting to bulkhead, chart-table or deckhead. Arrangements can also be made for pedestal fitting, if desired. The viewing angle can be adjusted to suit the individual requirements of the person using the instrument, and all the operating controls are on the face of the panel, so that the hand falls naturally upon them. A detachable visor is provided so that the screen can be viewed in a brightly-lit chart-room or in strong sunshine, and the panel is so arranged that both the screen and the range marker scale, which shows the distance of any observed object, are fully visible to the viewer when the visor is in use to exclude light.

A single switch starts and stops the "Radiolocator IV" and the set is in full operation within one minute of switching on. A gyro-compass repeater can be coupled up for "North-up" presentation of the display, and remote-display units, up to two in number, can be fitted without any alteration to the existing wiring. These remote displays are completely self-contained, and are provided with their own range rings, bearing indicator, &c., for independent observation of targets. The main display unit takes up rather less than two cubic feet of space, and the remote display units are of the same dimensions.

Automatic Change of Pulse Length

An important property of the "Radiolocator IV" which contributes largely to the excellence of the display, is the incorporation of an automatic change in the pulse length used when switching from the shorter to the longer ranges, or vice versa. It has so far been the general practice in marine radar installations to employ one single optimum pulse length for all ranges, despite the fact that the pulse length best suited for shorter distances does not necessarily give the best results on longer ranges. In the "Radiolocator IV" two pulse lengths are used, one for the 1 mile and 3 mile ranges, and a somewhat longer one for the 10 mile and 40 mile ranges, resulting in higher definition on the first two and brighter illumination of targets on the latter. The pulse length is automatically changed when switching over from the 3 mile to the 10 mile range or back again.

Automatic frequency control checks any tendency to variation of performance due to frequency drift, and comprehensive feed and voltage metering facilities are provided. A wave-monitor is built into the transmitter cabinet and special facilities are provided throughout for monitoring all circuits. The rectangular cabinet is specially ventilated, the whole of the front panel being louvred to protect the equipment by limiting the temperature rise. The various chassis and metering positions of the transmitter are all fully accessible from the front of the transmitter cabinet which can therefore be fitted in a narrow space without side access being necessary.



MAIN DISPLAY UNIT WITHDRAWN FOR SERVICING

Built-In Performance Indicator

The aerial scanner of the "Radiolocator IV" installation is fitted with a built-in performance indicator, which, apart from effecting a considerable saving in fitting time and in first installation costs, ensures that all "Radiolocator IV" installations are provided with a standard check on performance, regardless of the structural differences of individual ships. The scanner is also fitted with de-icing apparatus which may be switched on and off as necessary.

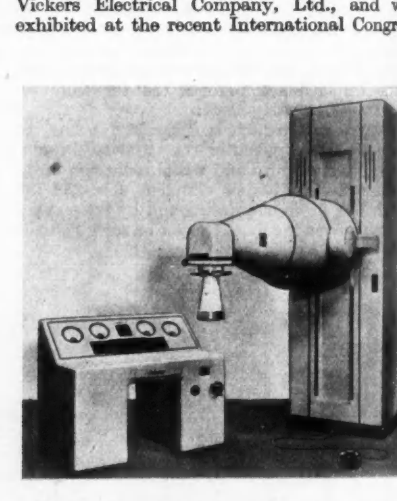
The speed of rotation of the scanner, and therefore the scanning rate, has been arranged for optimum "painting" of targets, and the positive drive of the magslip from the scanner motor ensures drift-free alignment of the display. The scanner can be mounted on an elevated structure or turret to provide an unhindered view over funnels, ventilators and bridge.

Advances in technique have made possible a considerable reduction in the number of valves employed. The "Radiolocator IV" uses only half as many valves as its predecessor, a fact which implies a substantial increase in reliability. Anti-vibration mountings on display and transmitter units also contribute to higher reliability by protecting components from shock in heavy weather.

The cabinets are constructed of non-magnetic materials to permit installation in close proximity to compasses, and all units are built on sliding rails to be fully accessible for inspection; and one of our illustrations shows the main display unit partially withdrawn from its cabinet. Adequate safety devices are incorporated for the protection of personnel engaged on maintenance work.

"Resomax 300" Deep X-Ray Therapy Equipment

THE accompanying illustrations show the general arrangement and construction of a new design of X-ray equipment for cancer treatment. It is known as the "Resomax 300," a joint product of the research and design staffs of Newton Victor, Ltd., and Metropolitan-Vickers Electrical Company, Ltd., and was exhibited at the recent International Congress of Radiology exhibition in London. Rated for continuous operation, at 300kVp and 20mA tube current, it has an X-radiation output of 80R per minute, free in air, at 50cm, and with a half-value layer of 2·0mm of copper, its performance is appreciably better than the specifications of the Ministry of Health and the Faculty of Radiologists, for equipment of its type.

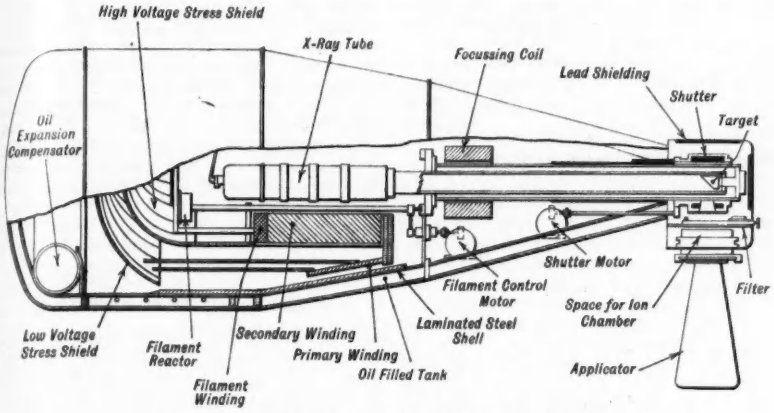


X-RAY EQUIPMENT AND CONTROL DESK

To the engineer, the "Resomax 300" is interesting mainly because it is the first set to incorporate a British-built, multi-section, sealed-off X-ray tube. High voltage is generated by a resonant transformer energised from a high-frequency supply of about 1000 c/s, derived

from a synchronous-motor-driven alternator, which makes the output independent of main voltage variations. A substantial saving of weight results from the use of a resonant transformer, which has no iron core.

As shown in our sectional view of the equipment, the sealed-off X-ray tube is mounted co-axially within the resonant transformer, the whole assembly being oil-immersed in a sheet steel tubehead. The resonant transformer consists of a series of pancake coils, comprising the primary winding, followed by the secondary winding, with a final coil to supply the X-ray tube filament. Appropriate tappings from these coils are connected to the intermediate accelerating electrodes of the multi-stage sealed-off X-ray tube to improve the uniformity of the voltage gradient over the whole length of the tube.



PART CROSS SECTION OF "RESOMAX" X-RAY TUBE

Electrons emitted from the filament and accelerated along the length of the tube impinge on the tungsten target located (as illustrated) at the right hand end of a metal tube projecting about 30in from the tank containing the oil-immersed resonant transformer. Being at earth potential, there is no difficulty about cooling the target tube with mains water, which eliminates the problems associated with the insulation of special pumps.

The complete tubehead assembly is mounted on a pillar stand and is provided with magnetically-braked motor-driven vertical travel of 78in and rotational movement of 360 deg. The drives for raising, lowering and rotating the source of X-rays are under push button control and all tube movements are clearly scaled. Doors in the rear of the stand give access to the drive mechanisms for maintenance purposes.

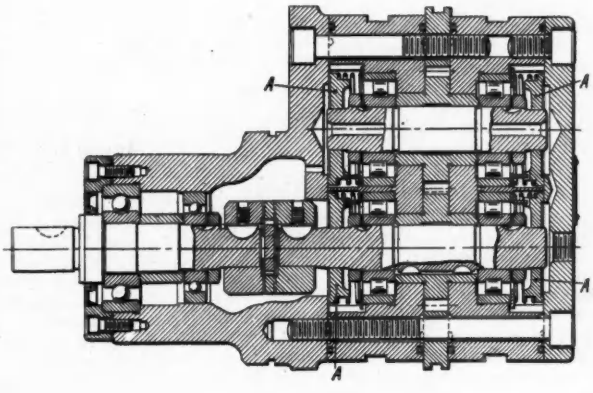
All the necessary operating controls and the associated instruments are incorporated in a "Resomax" control desk which is intended, normally, to be outside the treatment room, allowing the operator to be protected by lead-lined or concrete walls, from the effects of radiation. The control equipment includes an automatic treatment timer which closes the lead tube shutter and thereby cuts off radiation at the end of a pre-set period, at the same time giving an audible signal. In addition to an X-ray dosage meter, the control desk is provided with a milliameter and a voltmeter scaled in kilovolts. Control of the high voltage source is exercised by a small rheostat which is used to adjust the excitation of the high-frequency alternator, providing stepless control over the whole range of the potential.

High Pressure Gear Pumps

A NEW high-pressure gear pump now being manufactured by Keelavite Pumps and Motors, Ltd., of Allesley, Coventry, has been designed to maintain high pressures with consistent efficiency, both volumetrically and mechanically, over long periods. This pump, which is known as the firm's "GH" series, is made in four sizes. The smallest size has an output of 2 gallons per minute at a maximum pressure of 2000 lb per square inch, and the largest delivers 27 gallons per minute at 1500 lb per square inch, when working at 1500 r.p.m.

In order to eliminate friction and consequent wear on the sides of the gears when the pump is in operation, these units are centralised axially by hydraulic means in the pump casing. The makers state that the design and method of construction is such that an axial displacement of as little as 0·0001in in the gears automatically introduces a restoring force of more than 500 lb on the side of the gears with a pump working pressure of 1000 lb per square inch.

From the drawing we reproduce below it will be seen that passages drilled through the pump casing allow pressure oil to be fed into cavities formed at each end of both the driven and driving shafts of the pump. These cavities are sealed by means of the rings *A* at the extreme ends of the two shafts, and the pressure of the oil on the outer faces of these spring-loaded shafts maintains the axial balance of the gears.



AXIALLY BALANCED GEAR PUMP

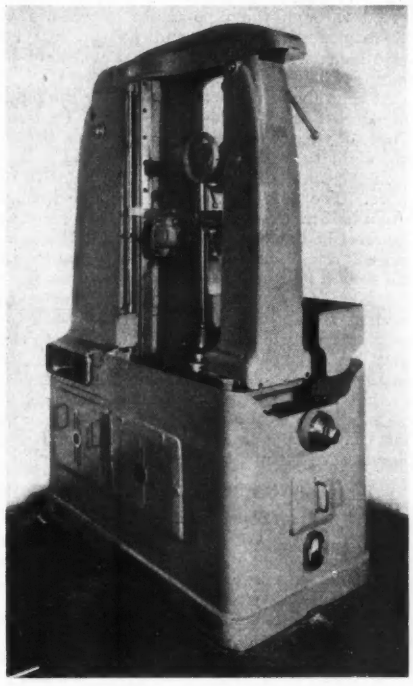
To enable axial balancing to operate efficiently it is necessary to allow a small degree of end float on the driving shaft and for this reason considerable care must be taken when coupling a pump to a prime mover. The pumps are therefore supplied complete with a driving adaptor so that belt pulleys or chain sprockets can be mounted directly on the adaptor shaft. Without a driving adaptor the pump can be directly coupled to an electric motor by using a flanged and spigoted adaptor with a chain coupling to allow for the driving shaft end float.

The pump casings are of light alloy and gears of Nitralloy steel are ground before and after nitriding.

A Vertical Spline Hobbing Machine

WE reproduce below a photograph of a recent development of the M.T.15 gear hobbing machine, made by David Brown Machine Tools, Ltd., of Manchester. This machine, in addition to handling helical spur and helical gears up to 15in diameter, is designed for cutting spline shafts up to 33in long with from four splines on 1½in diameter to twelve or more splines on 5in.

The new unit is built on similar lines to the original machine, and on it conventional and climb hobbing can be used without need for adjustment. The hob slide travels on double rectangular guides and the cutting stay for supporting the work has an over-arm brace attached to the upright for added rigidity.



SPLINE HOBBING MACHINE

The upright arm spans the full width of the bed, which houses a large sump and, in the rear, a gearbox of unit construction. Ground guides on the front face of the upright carry the hob slide saddle, which has two main components, the back and the swivel slides. The back slide moves in long guides and the swivel slide, which incorporates the hob spindle and driving gears, has a full turning circle of 360 deg. Movement of the hob slide is controlled by the lead screw, which is mounted on the lower surface of the back slide and engages with a revolving nut carried in the gearbox.

The dividing worm wheel is cut in position with the table and the worm is supported in an adjustable housing, enabling backlash to be reduced to a minimum.

All gears for drives to the hob and table are housed in a single gearbox in which provision is made for easy access to the speed, indexing and feed change gears. Automatic lubrication is supplied by a plunger pump mounted in the sump, and a coolant is fed to the hob from a centrifugal pump.

The machine is controlled from a central push-button station at the operating side of the machine, and adjustable stops govern movement of feed and rapid traverse, with safety stops to control the extreme limits of motion. A separate motor is provided for rapid traverse of the hob slide.

American Engineering News

(By our own Correspondent)

Pipe-line Crossing Hudson River

The sinking of a 26in pipe-line into the bottom of the Hudson River, between Edgewater, New Jersey, and West 134th Street, Manhattan, will be the most difficult engineering feat of the pipe-line project connecting the natural gas fields of Mercedes, in the lower Rio Grande Valley, to New York City. The project involves the laying of 1840 miles of steel piping, and is expected to be completed by the end of this year. Preparatory to sinking the pipe into the Hudson River, a 256ft. barge has been rigged up with a jet plough in order to furrow the river bottom to find out if any forgotten wrecks, anchors or other obstructions are in the deep underwater silt along the pipeline path. A 110ft long steel pipe with jets along 25ft of its lower end and 24in in diameter, is lowered through a well in the barge, and probes the underwater deposit as the barge slowly edges across the river. Water is being forced through the pipe under a pressure of 130 lb per square inch and at the rate of 3000 gallons per minute, using diesel-powered pumps of 330 h.p. capacity.

At the time of the actual sinking of the pipeline across the 1 mile width of the Hudson, a fleet of twenty 12ft barges, six derrick barges and eight tugs will make up a floating bridge from the middle of the river to the Manhattan shore. The 26in pipe sections will be welded into a half-mile length, which will be lowered to the river bed at the Manhattan end. The open end will remain above water in midstream until the second half-mile length is pushed out from the New Jersey shore. After a midstream welding, the entire length of 26in pipe, with 4in jet piping fastened to it, will be let down to the river bed. Expelled under pressure from 2in nozzles spaced every 4ft along the jet pipes, air and water will stir up the silt, resulting in the pipe sinking gradually into it to a depth of 25ft. The actual laying of the Hudson River pipe-line is expected to take two days.

Automatic Control Units for Machine Tools

Arma Corporation, a subsidiary of the American Bosch Corporation, of Brooklyn, has developed a series of electronic control devices applicable to a wide range of machine tools. The so-called "Armamatic" device makes use of a piano-roll type of operating master which is prepared on rolls of paper by punching the relevant data in rows of dots. The punched piano rolls travel past a system of "electronic fingers," which, in turn, actuate servo controls on transverse and longitudinal tool feeding mechanisms, thus producing parts automatically with the exception of machine tool loading and unloading. The devices may be applied to almost any machine tool, from simple lathes and milling machines to complex cam generators and jig borers. It is claimed that a model costing only about 1500 dollars can control repetitive output electronically, saving as much as 75 per cent of the time normally required to make a standard machine part to tolerances as close as plus or minus a fraction of one-thousandth of an inch. An interesting aspect of the process, and one which increases its economic value, is the fact that inspection devices can be applied within the control unit, so that final products originating from machine tools incorporating the "Armamatic" device may need no further inspection at all.

American Society for Testing Materials

The fifty-third annual meeting of the American Society for Testing Materials took place at Atlantic City, New Jersey, from June 26th to 30th, when more than 450 committee meetings and twenty-three technical sessions were held. Mr. J. G. Morrow, metallurgical engineer with the Steel Company of Canada, Ltd., was succeeded as president of the society by Mr. L. J. Markwardt, assistant director of the U.S. Forest Products Laboratory, Madison, Wisconsin. Metals and soils formed the subjects of the principal technical sessions. In the field of metals, gas turbine materials were discussed from points of view of corrosion, erosion, creep and effect of temperature. During the sessions dealing with soils, there were lively discussions on the reliability of the triaxial compression test and repeated pleas for a universal system of soil identification and classification. The various committee meetings, on the whole, did not deal with the creation of new standards, but rather concentrated on the improvement of existing A.S.T.M. specifications. Of importance to civil engineering contractors, however, will be one new standard on additions used in the making of air-entraining Portland cements (ASTM C 226—50T), which is being prepared by one of the cement sub-committees of the society.

German Wartime Patent Applications

A comprehensive guide to wartime German patent applications, which may now be used freely in allied countries, has been issued by the U.S. Department of Commerce. The guide is a subject index to the 200,000 German applications filed in the Berlin Patent Office between 1940 and 1945. Copies of the guide, entitled "Subject Outline of the Unpublished Applications for Patents Filed at the German Patent Office, 1940 to 1945," are available on request from the Office of Technical Services, U.S. Department of Commerce, Washington, D.C.

Submarine Construction

The U.S. Navy is continuing its post-war submarine development programme with the construction of two new classes of undersea craft. One is a new "Fast Attack" class of submarine, which will have greater submerged speed than the present fleet-type submarines, and will carry the latest electronic detection equipment. The other is an anti-submarine class of undersea fighter which will be smaller than any submarine built since 1918. A total of six "Fast Attack" submarines and three anti-submarine craft are being built. The first vessels of each class are expected to be completed in 1951. Submarines of the "Fast Attack" class will be shorter than the current 311ft fleet type, but will have about the same displacement of 1500 tons. They will have entirely streamlined superstructures, and will be equipped with Snorkel gear. The three anti-submarine vessels will be 195ft long, will displace 750 tons and will be adaptable to mass production. They will carry sonar and electronic detection equipment. Since the recent war, the U.S. Navy has been working to increase the submerged speed and underwater endurance of its submarines. Eighteen fleet-type submarines have been streamlined and equipped with improved storage batteries. In addition, three other submarines under construction at the end of the war were streamlined, giving the Navy to-day a total of twenty-one fleet-type vessels, all but two equipped with the Snorkel breathing tube.

Extrusion of Ferrous Tubes and Shapes

A new extrusion plant for the fabrication of tubes and sectional shapes in carbon and alloy steels is being built at Beaver Falls, Pennsylvania, by the Babcock and Wilcox Tube Company, which is manufacturing seamless and welded tubing. The process to be used under licence was developed by Comptoir Industrial d'Etirage et Profilage de Metaux in Paris during the war. It offers a method of dealing with alloys which are difficult or impossible to fabricate by conventional methods. The process is said to introduce a new concept of lubrication of hot metal which solves the problem of lubrication and of thermal insulation of the die and billet holders. The extruding operation is carried out in a few seconds at constant temperature, giving the extruded product uniform mechanical characteristics throughout its entire length.

Manufacturing Methods Pilot Plant

A 17-acre plant at Adrian, Michigan, which produced aluminium extrusions for aircraft during the last war, has been set up as a manufacturing methods pilot plant by the Air Materiel Command of the U.S. Air Force. This large manufacturing research centre is intended to be used as an industrial proving ground for metal forging and extruding operations. Fifteen extrusion presses, already installed, range from 1650 tons to 5500 tons capacity. Four large hydraulic presses which were removed from Germany, and range from 600 tons to 15,000 tons, are in process of installation, and the construction of a 75,000-ton press is being considered. In addition, the pilot plant has a laboratory tool room and ample furnace facilities. Industrial companies are invited to make use of these press and forge facilities and to conduct pilot runs on new tools, dies and other equipment that may lead to improvements in their products and processes. Fees are charged only to take care of operating and maintenance costs. Promising work has already been done on extruding steel, aluminium and magnesium, and work on titanium and molybdenum will take place in the near future.

50-Million-Volt Betatron Installation

A 50-million-volt betatron, designed and constructed by the General Electric Company, has been installed in the new betatron laboratory of the National Bureau of Standards, Washington, extending the Bureau's high energy research facilities into the region from 2 million to 50 million electron volts. For work at even higher energies, a 180 million-volt synchrotron will be installed at the Bureau in 1951. The 50Mev betatron has 180 X-ray bursts per second, and it operates at an X-ray output level of 200 "R" per minute at a distance of 1m from the target. The research programme of the National Bureau of Standards concerning this equipment has four main aspects: the investigation of shielding and protection against high-energy radiations, the medical applications of these radiations, their industrial applications and their basic physical properties. The Bureau has already established standards for protection against low energy X-rays, and the new betatron research programme is intended to fill the need for standards of protection in the higher regions now available to medicine and industry.

Cross-Country Television Network System

The Federal Communications Commission has authorised the American Telephone and Telegraph Company to bridge the remaining gaps in the transcontinental television circuit by constructing a chain of microwave relay stations between Chicago and San Francisco. Fifty-five stations will be required between Omaha, Nebraska and San Francisco to carry transmissions across the Rocky Mountains. Completion of the first transcontinental circuit is expected by the end of next year.

Atomic Power Plant for Submarines

Construction work will start this month on the first experimental atomic power plant for submarines of the U.S. Navy. The Argonne National Laboratories and the Westinghouse Electric Corporation are co-operating on the project under the direction of the Atomic Energy Commission, and the dry-land model of the nuclear engine will be built at Arco, Idaho. The cost of the project has been estimated at 25,000,000 dollars. Arco is the site of the Commission's testing station for atomic engine reactors, and research and development work preliminary to actual construction has been going on for three years. A second experimental atomic engine, incorporating a different system of design, is to be built at West Milton, New York, by the Knolls atomic power laboratory of the General Electric Company. In both projects it is intended to use the heat of atomic fission in order to generate steam which, in turn, will be fed through steam turbines of conventional design. It is hoped that the nuclear power plant, with its complete freedom from atmospheric oxygen, will greatly increase the operating radius and the speed of submarines, at present limited by the performance of electric battery propulsion plant.

Industrial and Labour Notes

Engineering and Shipbuilding Wages

The informal committee set up by the Engineering and Allied Employers' National Federation and the Confederation of Shipbuilding and Engineering Unions met on Thursday of last week to discuss the possibility of resuming negotiations over wages. Since the claim for a general increase of £1 a week was presented towards the end of last year, no further consideration has been given to the new wages structure on which negotiations had started. It is understood that no final decisions about resumed negotiations were taken at the meeting last week. The informal committee, it will be recalled, was formed at the suggestion of the Ministry of Labour.

A similar procedure has now been decided upon for the shipbuilding industry. Representatives of the Shipbuilding Employers' Federation and the Confederation of Shipbuilding and Engineering Unions met officials of the Ministry of Labour last week. It was agreed that an informal committee, representing the two organisations, should be appointed to explore the position which has arisen since the rejection of the £1 a week claim.

Trade Disputes

The Ministry of Labour has now published some details of stoppages of work, through industrial disputes, which occurred in the United Kingdom during June. In all, 140 stoppages were in progress at some time during the month, involving 28,400 workers and causing an aggregate loss of 95,000 working days. There were eighty-six stoppages in the coal mining industry, involving 8400 workers and resulting in a loss of 16,000 working days. There were also twelve stoppages of work in June in the engineering industry, one of which lasted more than five days. There were 6800 workpeople affected by these stoppages and 20,000 working days lost.

The Ministry has also published figures about stoppages of work through disputes in the first six months of this year. In that period 755 stoppages began, the number of workers affected being 146,900 and the aggregate number of working days lost 573,000. In addition, 14,000 working days were lost at the beginning of this year by 900 workers who had become involved in stoppages which started before the end of 1949. In the first six months of last year there were 826 stoppages of work through disputes, involving 240,200 workers and bringing about an aggregate loss of 924,000 days.

The Size of Manufacturing Firms

A requirement of the Undertakings (Records and Information and Inspection of Premises) Order, 1943, is that all employers with more than ten employees in manufacturing industry supply information to the Ministry of Labour on appropriate forms that are sent out every month. By analysing the information thus provided it is possible to see the growth or decline—as far as numbers employed are concerned—of manufacturing industry in this country.

Recently, the Ministry of Labour has published the results of a survey of this information. It shows that in December, 1949, there were 55,129 establishments in Great Britain, with more than ten employees, from which particulars were received. Of that total, 41,423 establishments, or 75 per cent, had less than 100 employees and 15 per cent had between 100 and 250 employees. Establishments with 250 employees or more thus represented only 10 per cent of the total. Into this last category there came 342 establishments, each with 2000 or more employees, and together they accounted for 18 per cent of the total employment in manufacturing industry.

The survey also showed some interesting facts about the size of establishments in individual manufacturing trades. In a group classified under "Engineering, Shipbuilding and Electrical Goods" 8338 establishments are included, and in December last they were employing 1,574,000 people. Of these establishments, 107 were each employing 2000 or more people; 214 were employing between 1000 and 2000; 367 were employing from 500 to 1000; 1827 were employing between 100 and 500; 3381 were employing between 25 and 100; and 2442 were employing from 11 to 25 people only.

Industrial Activity in S.E. England

At the monthly meeting of the London and South-Eastern Regional Board for Industry, which was held last week, it was reported that firms in the area were entering increasingly into the export trade, and that economic activity generally remained at a high level.

It was stated that a firm in the region engaged in manufacturing building contractors' equipment had recently received an order for concrete elevating plant for delivery in Jugoslavia. This order was obtained in direct competition with Germany and Italy, and, it was claimed, that although the British firm quoted a higher price and somewhat longer delivery, the order was gained on quality and superiority of design.

Another matter brought to the Board's attention was that a building licence had been granted recently for the construction of an oil refinery in the Isle of Grain at the mouth of the Medway. Work on this project, which is for the Anglo-Iranian Oil Company, Ltd., was about to begin, the total cost being put at about £15,000,000.

There was some concern expressed at the meeting, by representatives from South London, about the lack of information relative to workers' transport in that area during next year's Festival of Britain.

Coal Output

Recognised holidays are now naturally affecting coal output in Great Britain, although, so far, not quite to the same extent as last year. In the week ended July 29th production from the deep mines amounted to 3,625,800 tons and from opencast workings 282,800 tons, giving a total for the week of 3,908,600 tons. Deep-mined tonnage lost through recognised holidays was estimated at 312,300 tons. In the preceding week, that ended July 22nd, total saleable output was 3,881,400 tons. The estimated loss on account of holidays was 468,700 tons and a further 24,600 tons was lost as a result of disputes.

Manpower in the coal-mining industry continues to decline. In the week ended July 22nd the number of wage earners on colliery books was 696,800, compared with 697,600 in the preceding week and 720,700 a year ago. The number of face workers employed in the week ended July 22nd was 288,300, compared with 296,600 in the corresponding week of last year. Voluntary absenteeism, however, is rather less than at this time last year, and there is a slight improvement in output per man-shift at the face, the latest available figure being 3·16 tons, compared with 3·08 tons a year ago.

Total coal consumption, including exports and bunkers, in the week ended July 22nd, was 3,579,000 tons and the total distributed stocks were 12,411,000 tons. In the comparable week of last year those figures were 3,528,000 tons and 14,039,000 tons respectively. In the first thirty weeks of this year total coal production amounted to 125,889,800 tons, compared with 123,268,700 tons in the corresponding period of 1949.

Dust and Fumes in Ironfoundries

The Joint Iron Council, in collaboration with the Council of Ironfoundry Associations, has decided to intensify work upon problems of dust and fumes in ironfoundries, and to provide an advisory service on how they may best be dealt with in foundry practice. This work, it is stated, is being carried out through the British Cast Iron Research Association which is financed largely by the Joint Iron Council. A special committee of the Research Association is supervising the work, and is maintaining close co-operation with the joint standing committee on Conditions in Ironfoundries, set up by the Factory Department of the Ministry of Labour.

The Position of the Foreman in Industry

In the course of a paper read before the Leeds branch of the Institution of Works Managers, Mr. C. W. Mustill said that the position of the foreman in British industry to-day is worthy of the most careful consideration. In the average small workshop the place of the foreman has always been clear and through him there is a direct and clearly defined chain of communication and command between the management and workers. In addition he is often responsible for details of manufacturing technique and planning. Before the war this clear-cut conception showed marked signs of modification in the larger factories, and the traditional influence of the foreman was reduced by the gradual increase in functional organisation. With the increasing introduction of specialists such as personnel managers, progress chasers, training officers, &c., the foreman became uncertain of his place in the scheme of things.

Now, however, said Mr. Mustill, there were clear signs that the traditional status of the foreman was being restored. As the foreman was closer to the worker than the management, it must be his role to interpret the policy and orders, and a very great deal depended upon his method of interpretation. In selecting a foreman the question was whether it was better to promote from within an organisation or introduce someone entirely new. It was argued by some firms that it was always difficult for an upgraded man to control those with whom he had previously worked as an equal, and that a man with long service might have absorbed the methods, training and traditions of a department to such an extent that he would not wish to make any changes. According to another school of thought there was much to be said for continuity of method; promotions from within an establishment encouraged the best men to work for the day when they would be made foremen. In Mr. Mustill's view, all things being equal, it was best to make promotions from within, for, if a promoted foreman had qualities of leadership, he would earn the respect of his fellow-workers. The incentive provided by the prospect of being a foreman was a very real one, although on no account should a man be promoted for sentimental reasons. One golden rule which the speaker considered should be kept in respect to foremen was always to have an understudy available at short notice.

Indian Imports

It has been decided by the Government of India to permit the free import of certain raw materials essential for the maintenance of industrial production, and certain other goods required for maintaining essential supplies in the country. The permit will apply to goods shipped on or before December 31, 1950, and a new open general licence has been issued. The licence consists of two schedules, one containing a list of goods which can be imported from all countries except South Africa, and a second schedule containing a list of goods the import of which will be permitted freely from soft currency countries only. Amongst the goods covered by the first schedule are certain specified non-ferrous metals, ball and roller bearings, graphite and carborundum, crucibles, textile chemicals, X-ray films, sulphur, &c. The goods covered under the second schedule include iron and steel electrodes, conveyor belting, a number of cycle accessories, and explosives.

French Engineering News

(From our French Correspondent)

Aircraft construction in France is dealt with in the Administrative Council's report on S.N.C.E.C.M.A. The Argenteuil factory, which had been used partly for tractor construction and partly for various aeronautical activities, was closed by a decree of August, 1949, and aeronautical work was transferred elsewhere. The S.N.C.A.C.'s Billancourt factory was transferred to S.N.C.E.C.M.A., and is already producing 12S engines. Technically, the company's work was profoundly modified : owing to reduction of credits, study of the "28V," 2800 h.p. piston engine, the "TA 1000," 6000 h.p. turbine engine and the "14U" radial engine prototypes were abandoned. The "14X," 1400 h.p. radial engine prototype and the "TB 1000," 1400 h.p. turbine engine prototype were both satisfactory in tests. The company's output was considerably reduced by the closing of the Argenteuil factory.

The reorganisation committee for the aircraft industries also decided to close the factories of the S.N.C.A.N. at Issy-les-Moulineaux and Sartrouville, but the latter is still being maintained. During 1949, only the Havre and Sartrouville factories were able to continue normal production, on the Noroit N.1400 amphibious aircraft. The Meaulte, Mureaux and Bourges factories were only occupied with repairs or mechanical construction work for private industry. The end of 1949 saw an improvement, with orders for several new productions, but there was a fall in manpower from 5408 on December 31, 1948, to 4551 on December 31, 1949, and further reductions are expected. The number of engineers and designers was reduced from 303 to 148.

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About four million dollars worth of machinery and tools have been bought from America through Marshall Aid, for the development of roads, iron ore and agriculture in Africa. A series of six projects will develop these African resources. The first scheme involves the construction of 6880 kilometres of roads in French West Africa, 13,600 kilometres in French Equatorial Africa and 320 kilometres in the Cameroons. Konakry iron ore is the main element of French Guinea's economic programme which envisages development of hydraulic resources and the port of Konakry. Heavy machinery to be used for works to prevent soil erosion has also been purchased.

* * *

Reconstruction of the Corbeil factory of the Sté. Nouvelle des Ets. Decauville is almost completed and modernisation of machinery is being carried out. Activity last year included the construction of rolling stock for Luxemburg and light metal carriages for the Camargue railways. "C-10" carriages for the S.N.C.F. were also constructed as well as autorail-cars and rolling stock for French Colonial railway systems. Activity of the Marquette factory was mainly concentrated on mining and public works material.

During 1949, the Sté. Lorraine des Anciens Etablissements de Dietrich et Cie delivered sixty new trucks and twenty carriages to the S.N.C.F. Restricted credits caused truck deliveries to drop from one hundred to forty or fifty trucks monthly. The company also received orders for passenger coaches from Spain and goods trucks from Pakistan.

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Stocks held in the French mines continue to increase, despite reduced production owing to the paid holiday period. On July 8th, stocks amounted to 2,436,000 tons against 2,209,000 tons on June 3rd. Nevertheless, the situation is not considered to be serious, provided the full return to work in the Autumn absorbs the surplus. Stocks held in the Nord and Pas-de-Calais basin amount to 1,500,000 tons, or three weeks production, but out of this total, real commercial stocks amount to less than 750,000 tons. The position for secondary products is more difficult, due to reduced orders from Electricité de France. It is believed, however, that stocks will be disposed of when the thermal plants are fully employed in the winter.

Notes and Memoranda

Rail and Road

LOCOMOTIVE FILM.—Entitled "North British," the North British Locomotive Company, Ltd., has recently sponsored the production of a documentary film dealing with the construction of locomotives. Every phase during the building and assembly of many classes of railway engines is covered by the film, including comprehensive views of the various shops and shots of the modern equipment, and of the numerous operations being carried out during the production of cylinders, axleboxes, frames, valve mechanism and boilers. Available in 16mm and 35mm sizes with the sound track in several languages, the film is of special interest to those engaged in rail transport and copies can be obtained on loan, without charge, upon application to Mr. E. Cook, Big Six Film Unit, 35, Endell Street, London, W.C.2.

STEAM LOCOMOTIVES FOR INDIA.—Six 65-ton 0-6-2T steam locomotives, built by the Hunslet Engine Company, Ltd., for the Calcutta Port Commissioners, are intended for handling freight trains up to 1200 tons in weight over the dock lines. The engines have two outside 16in by 24in cylinders, driving the third pair of 3ft 10in coupled wheels, and with a boiler pressure of 210 lb per square inch exert a tractive force of 23,800 lb. Adhesion weight in full working order is 49¼ tons. The non-superheater boiler has an evaporative surface of 1030 square feet, and a grate area of 18 square feet. Side and rear tanks carry a total of 2000 gallons of water and the bunker holds 2½ tons of coal. The new locomotives have just been shipped to Calcutta and six further locomotives of the same design now under construction at the Hunslet works will be delivered next year.

HALF-DECKED PUBLIC SERVICE VEHICLES.—The use on the roads of a new type of single-decked bus or coach, officially termed a half-decked public service vehicle, in which the seats are arranged at two different levels but are served by one gangway, has been made possible from July 29th, under special Regulations made by the Minister of Transport. The overall length of such vehicles is limited to 30ft and the seating capacity to fifty passengers, excluding the driver (and conductor, if one is carried) while the carriage of standing passengers is prohibited. Generally, the half-decked vehicles are subject to the same conditions as single-decked public service vehicles, but as an additional safety measure, the new Regulations require the provision of an emergency exit in the roof of half-decked vehicles besides the two exits, one of which may be an emergency exit, required on single-deckers.

Air and Water

DIESEL ENGINE CRANK-CASE SAFETY PRECAUTIONS.—The paper entitled "Diesel Engine Crank-Case Safety Precautions," read by C. C. Pounder, chief technical engineer of Harland and Wolff, Ltd., before the North-East Coast Institution of Engineers and Shipbuilders, in February of this year, has been reprinted, including the discussion, the written discussion and the authors' reply.

PRESTWICK AIRPORT.—The Minister of Civil Aviation has decided to make an order authorising the compulsory purchase under Section 23 of the Civil Aviation Act, 1949, of certain lands and buildings included within Prestwick Airport. A draft of this Order was published in January, 1950, and certain objections were subsequently made to it by persons directly affected by its provisions. Accordingly the Minister, under the powers conferred on him, appointed a Commissioner, Sheriff J. R. Philip, O.B.E., K.C., to hear the objections. The hearing took place in Ayr on April 25 and 26, 1950, when representations were heard on behalf of Scottish Aviation, Ltd., the sole objectors then remaining. The Minister has carefully considered these representations, together with the report of the Commissioner, and has decided to confirm the Compulsory Purchase Order. Nevertheless, the Minister is anxious to leave Scottish Aviation, Ltd., in occupation of the factory premises which it needs for so long as it reasonably requires. He has therefore decided to offer the company a lease for a term of 99 years, the minimum period said by the company, at the hearing of objections, to be necessary for the development of its long-term plans. The purchase of Prestwick Airport by the Ministry of Civil Aviation is in accordance with Government policy announced in 1945 and approved by Parliament. This policy recognises that large modern international airports cannot be built and maintained without heavy capital and maintenance expenditure beyond the resources of private ownership. Prestwick Airport, the Ministry says, is an example of an aerodrome almost wholly developed to its present international standard at State expense.

Miscellanea

RURAL TELEPHONE KIOSKS.—During the year commencing September 1, 1950, the Post Office will provide 685 telephone kiosks in the rural areas of England and Wales. This is the second annual quota under a new scheme inaugurated last year between the Post Office and the Rural Districts Councils' Association, whereby an annual quota of kiosks is allocated to each county; the places where the kiosks will be installed are decided in the light of recommendations of each County Branch of the Association. Kiosks provided on highways for passing motorists are not included in the scheme.

A SUMMER SCHOOL OF PRODUCTION ENGINEERING.—We have received from the Institution of Production Engineers particulars of a summer school of production engineering, which is to be held at St. Peter's Hall, Oxford, from August 30th to September 3rd next. The theme for the school will be "The Science and Practice of Engineering Applied to Production." Facilities will be provided for an interchange of views on specific aspects of production engineering, between those responsible for education and training and those in industry responsible for production. Particular attention will be paid to the development of teaching methods.

ARMAMENT AND ELECTRICAL TRADES SCHOOL OPEN DAY.—The Armament and Electrical Trades School, Martinique Barracks, Bordon, Hants, will be open to the public from 11 a.m. on Saturday, August 19th. This school consists of three wings. The mechanical wing giving training in various stages of bench fitting, blacksmithing, beating and soldering, tinning and metal machining; the electrical wing training men of R.E., R.E.M.E., and electrical fitters, R.A., and the armaments wing training men in repair work on all types of guns and searchlights. On the open day the public will be able to inspect the laboratories and workshops and will also see various types of service equipments.

RESEARCH FELLOWSHIP IN ELECTRICAL ENGINEERING.—The Governors of Queen Mary College have accepted an offer made by W. T. Henley's Telegraph Works Company, Ltd., for the establishment of a Research Fellowship in Electrical Engineering at Queen Mary College. The Fellowship will be known as the W. T. Henley Fellowship and, as the maximum remuneration is £600 per annum, it will be possible to attract to the College senior research men who have already had some works experience. It is hoped that the investigations carried out by the W. T. Henley Fellows will be more particularly in the field of dielectrics, high-voltage engineering, and arc-interruption phenomena, for which the resources of the College are particularly good.

MANUFACTURE OF SILICONES IN GREAT BRITAIN.—Albright and Wilson Ltd., who, for the past four years have acted as the distributors of silicones in Great Britain for the Dow Corning Corporation of America, announce their intention to commence manufacture of silicones in this country. Silicone products are available in many forms, including heat-stable, water-repellent insulating compounds for sealing high-tension ignition systems, and high-frequency equipment; mould release agents and foam inhibitors; special lubricants for operating at extremely high and low temperatures; heat-stable, inert liquids for use as damping and hydraulic fluids; heat-resistant waterproof materials for use in electrical insulation, and as bonding agents and protective coatings; and "Silastic" rubber—a silicone rubber which is flexible at −110 deg. Fah. and at 500 deg. Fah., and is available in grades suitable for moulding, extruding, coating, laminating and caulking.

ELECTRIC RESISTANCE STRAIN GAUGE METHODS.—It is proposed to hold the third Cambridge summer school on electric resistance strain gauge methods in Cambridge from Monday, September 25, to Saturday, September 30, 1950. This summer school will be run on similar lines to those held previously, and it will be run by the Cambridge University Engineering Department jointly with the Stress Analysis Group of the Institute of Physics. The purpose of the summer school is to provide graduates in engineering, physics or allied subjects who wish to use E.R.S. gauges with the introductory theory and practical instruction which it is not easy for the beginner to obtain. The course will be designed for beginners and it will be assumed that those attending the course have not used E.R.S. gauges before. Particulars and application forms may be obtained from the hon. secretary of the Stress Analysis Group, Mr. E. K. Frankl, Engineering Laboratory, Cambridge.

British Patent Specifications

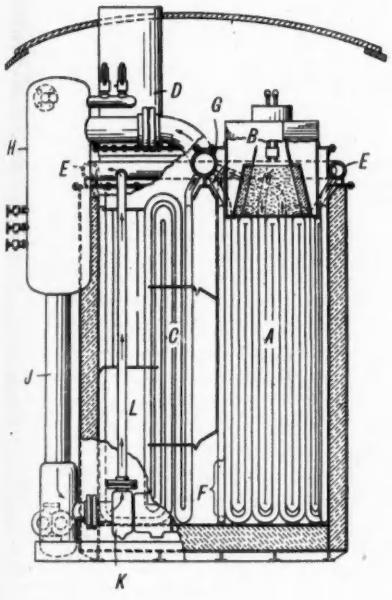
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

STEAM GENERATORS

640,078. June 7, 1948.—IMPROVEMENTS IN STEAM GENERATOR, Combustion Engineering-Superheater Inc., of 100, West 10th Street, Wilmington, Delaware, U.S.A.

This invention relates to steam generators and particularly to generators of the forced circulation type, which are of high capacity and compact construction, for trains hauled by either electric or diesel-electric locomotives. Referring to the drawing, the steam generator has a U-shaped gas passage, one leg of which forms a furnace chamber *A* downwardly fired by fuel burner means *B* and communicating through its inner side wall at the lower end with the adjacent convection passage *C* from the upper end of which the spent gases pass to a stack *D*. As shown, the walls of the furnace chamber are lined with radiantly heated steam generating surfaces comprising generally flat, grid-like tube coils, each made up of parallel pipe lengths disposed in contacting relation to form a water wall and interconnected at adjacent



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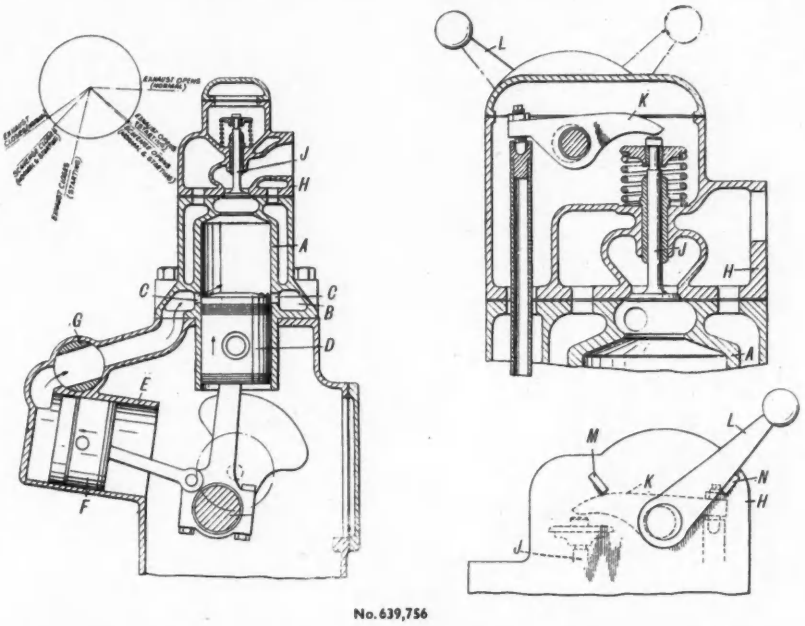
ends by integral return bends to provide for series flow through the tubes making up each coil. The right-hand side of the furnace chamber is semi-circular and accordingly the coils are shaped to arcuate form in order to lie against the walls of the furnace. The upper end portion of the tube length at one end of each coil is connected to a water distributing header *E*, which, as shown, is a tubular member bent to form a substantially complete loop extending around the periphery of the upright casing of the steam generator at its upper end. To provide for the flow of gases from the furnace *A* into the convection passage *C* alternate tubes of the coils that lie along the inner wall of the combustion chamber do not extend clear to the bottom of the furnace in order to provide openings *F* (Fig. 1) for gases to pass into the convection passage. As shown in the drawing, the steam generating surface in the convection passage *C* consists of several coil units made up of tube lengths serially interconnected for fluid flow by return bends and having the constituent tubes disposed in spaced relation in several parallel rows so that the tubes of the element are distributed among several parallel planes. From header *E* water enters the end portion at the upper end of the initial tube in one of the rows making up each element and is discharged into collecting header *G*. The collecting header discharges the mixture of steam and water into the separator drum *H* from which the water flows through a downcomer *J* to the intake of the circulating pump *K* to be fed by the latter through the pipe *L* into the supply header *E*. If it becomes necessary to remove any of the steam generating surface, the detachment of stack *D* together with the top plates of the generator and the burner assembly exposes the coils both in the furnace *A* and convection passage *B*.—*July* 12, 1950.

INTERNAL COMBUSTION ENGINES

639,756. March 15, 1948.—IMPROVEMENTS IN OR RELATING TO INTERNAL COMBUSTION ENGINES OPERATING ON THE TWO-STROKE CYCLE WITH COMPRESSION IGNITION, Harry Ralph Ricardo, of 21, Suffolk Street, Pall Mall, London, S.W.1, and George Allen Holt, of Bridge Works, Shoreham-by-Sea, Sussex.

This invention relates to internal combustion engines operating on the two-stroke cycle with compression ignition and particularly of the type in which the scavenge and working air supplied from a pump cylinder (whose piston is phased at or about 90 deg. in advance of the working piston) is admitted



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through ports in the wall of the working cylinder, which are controlled by the piston therein, the exhaust gases passing out through one or more ports in the head of the cylinder and controlled respectively by poppet valves. The object of the present invention is to facilitate the starting of such engines and to improve the no-load idling running. In the construction illustrated the engine comprises a crankcase supported on and partly within which is a working cylinder *A* incorporating a scavenging belt *B*, from which lead a series of scavenging ports *C*. The crankshaft is connected to a working piston *D*, the arrangement being such that at the end of its outstroke the piston uncovers the scavenging ports *C*. Mounted upon the crankcase is a pump cylinder *E*, the axis of which is approximately at right angles to the axis of the working cylinder *A*. The cylinder *E* communicates through a transfer passage controlled by a rotary valve *G* with the scavenging belt *B*. The valve is driven so that it closes the passage at the end of the delivery stroke of the pump piston *F* and thus locks a compressed charge of scavenging air in the passage and belt for delivery through the scavenging ports when the working piston *D* next uncovers them. The construction and arrangement of the valve *G* is described in the present applicant's Specification No. 522,001. The cylinder *A* is formed with a combustion chamber and is closed at its outer end by a cylinder head *H* in which is formed an exhaust port controlled by a mechanically operated poppet valve *J*. The poppet valve is arranged to be operated by one end of a rocker *K*, the other end of which is acted upon through the usual adjusting screw by the upper end of a push rod operated by a cam. The rocker *K* is mounted upon a pivot pin, the part of the pivot pin constituting the journal bearing on which the rocker rocks being, as shown in the drawings, eccentric with respect to the end portions of the pin which are mounted in bearings in the cylinder head *H*. One end portion of the pivot pin extends outside the cylinder head and has rigidly connected to it a lever *L* capable of rocking through approximately 90 deg. between stops *M* and *N* on the cylinder head. Thus the axis of the part of the pin constituting the journal on which the rocker rocks can be raised and lowered to predetermined degree. The arrangement is such that when the lever *L* is in the position shown at *M* so that the journal of the rocker is in its lower position, the exhaust valve *J* opens at the point in the cycle indicated as "Exhaust Opens (Normal)" and closes at the point indicated by "Exhaust Closes (Normal)," whereas with the lever *L* in the position *N* shown in full line so that the pivotal axis of the rocker is in its raised position, the exhaust valve is opened at the point indicated as "Exhaust Opens (Starting)" and closes at the point indicated as "Exhaust Closes (Starting)." The points of opening and closing of the scavenging ports *C* by the piston *D* are indicated respectively by "Scavenge Opens (Normal and Starting)" and "Scavenge Closes (Normal and Starting)." It will therefore be seen that for normal running the exhaust valve opens considerably in advance of the opening of the scavenging ports and closes just after the closing of such scavenging ports, whereas with the lever *L* in its other position, in which the effective clearance between the rocker and the exhaust valve is considerably increased, the exhaust valve opens at approximately the same moment as the scavenging ports and closes considerably before such scavenging ports close and only just after the piston has passed bottom dead centre. Thus, during starting conditions there will be compression of the charge in the cylinder *A*, the belt *B*, the transfer passage and the cylinder *E* from the moment when the exhaust valve *J* closes until the scavenging ports *C* close, whereby the final density and temperature of the charge when the piston *D* has completed its compression stroke is appreciably increased as compared with what would be the case if the exhaust valve closed at the point in the cycle indicated as "Exhaust Closes (Normal)."—*July* 5, 1950.

GAS TURBINES

640,143. May 15, 1946.—IMPROVEMENTS IN OR RELATING TO STEEL FOR RESISTING HIGH TEMPERATURES, CHIEFLY FOR GAS TURBINES, Société Rateau, of 40, rue du Colisée, Paris, Seine, France.

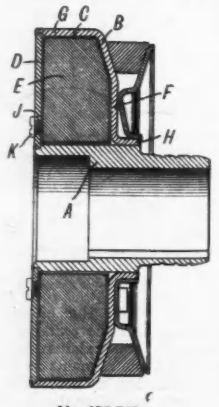
The invention has for its object novel compositions of steel, the mechanical properties of which when hot are substantially better than those of the known steels adapted to resist high temperatures. Such steel is of particular interest for the production of members of gas turbines such as movable blades, diffusers, wheels, combustion chambers and the like. The properties of this steel when hot may be considerably improved by suitable mechanical and thermic treatments. The steels described in this patent are austenitic steels, the range of composition of which is the following: chromium from 14 to 20 per cent, nickel from 7 to 18 per cent, tungsten between 3 and 10 per cent, cobalt from 4 to 15 per cent, carbon from 0·10 to 0·60 per cent, balance, iron and the usual impurities. These steels are submitted to a thermal treatment comprising a heating for a few hours at a temperature between 855 and 1175 deg. Cent. Further contents of 0·5 to 2·5 per cent of titanium or of niobium (or in total when both are present) may be added. The steels may contain carbon 0·25 per cent, 7·70 per cent nickel, 17 per cent chromium, 13·70 per cent cobalt and 9·80 per cent tungsten, the balance being iron with the usual impurities. Quenching

in air, in water or in oil from a temperature of 1150 deg. to 1175 deg. Cent. is followed by an annealing for two to eight hours at a temperature between 855 deg. and 950 deg. Cent. and finally a slow cooling inside the furnace in place of heat treatment. After forging, rolling, casting or welding, the steels are subjected to one or more successive heatings effected between 855 deg. and 950 deg. Cent. for two to eight hours followed by a cooling in air, in water or in oil, in place of heat treatment.—*July* 12, 1950.

VIBRATION DAMPERS

638,755. June 19, 1947.—IMPROVEMENTS IN OR RELATING TO A VIBRATION DAMPER AND METHOD OF DAMPING, The Houdaille-Hershey Corporation, of 2188, National Bank Building, Detroit, Michigan, U.S.A. (Assignees of Bernard E. O'Connor).

This invention relates to improvements in flywheel vibration dampers for overcoming torsional oscillations or vibrations in rotary masses such as crankshafts. In all forms of the damper, a high inertia damping mass in the form of a flywheel is housed within a casing, the walls of which are in close proximity to the opposing walls of the flywheel, and a viscous fluid, such as a silicone, intervening between the casing and the flywheel, affords a yieldable coupling due to its drag and shear resistance tending to restrain relative motion, especially high-speed motion, between the flywheel and the casing. Whereas it has previously been deemed essential to afford a bearing at the inner diameter of the flywheel to maintain the flywheel concentric with the axis of the damper, it has been found that improved results are attained where the inside diameter of the flywheel is clear of the opposing hub or wall of the casing and the flywheel is substantially free floating within relatively close limits in the casing. The form shown in



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the drawing is especially adapted for dampening vibrations in crankshafts of internal combustion engines where a fan drive or belt-like pulley is required. In this form a hub *A* carries a casing member *B* providing a flywheel chamber *C* initially open at one side but closed by means of an inset ring plate *D*, after a flywheel *E* is assembled within the chamber. The casing member comprises a sheet metal stamping having a side wall *F* and an annular flange-like outer peripheral wall *G*, while an axially extending inner marginal annular flange *H* affords an embracing abutment about the hub *A* and is preferably welded thereto. The inset closure plate is preferably flush with the edge of the peripheral wall flange and the end of the hub and is permanently secured in place by means of welding. Filler openings *J* in the plate *D* are closed by filler plugs *K*. During slow revolutions of the damper, the flywheel and the casing will revolve substantially together by reason of the lubricated bearing relation between them. At such low speeds the vibrations are of relatively low magnitude and the viscous fluid acting as a lubricant between the contacting surfaces of the flywheel and the housing may permit some relative displacement of the flywheel and casing with only low order vibration damping from frictional resistance of the lubricated bearing surfaces. At high speeds the viscous fluid becomes more and more resistant to relative movement of the flywheel and casing and under centrifugal force acts to equalise the peripheral and side spacings between the fly-wheel and the casing, thus affording substantially uniform shear films in such spaces. This provides a relatively strongly fluid coupling between the flywheel and the casing, which is highly resistant to either relative rotary or axial movement of the flywheel and casing and thereby operates with high efficiency in damping torsional as well as, to a certain extent, axial vibration in the associated shaft or other rotating mass with which the damper is operatively related.—*June* 14, 1950.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of British Chemical Manufacturers

Fri., Sept. 29th, to Sun., Oct. 1st.—Chemical Works Safety Conference at Scarborough.

Association of Supervising Electrical Engineers

Tues., Aug. 15th.—S.W. LONDON BRANCH: Compton Hall, Compton Road, Wimbledon, S.W.19, "Television," C. E. Juggins, 8.15 p.m.

Wed., Aug. 16th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Brains Trust," 7.30 p.m.

British Association

Wed., Aug. 30th, to Wed., Sept. 6th.—Annual meeting in Birmingham.

Institute of Metals

Mon., Sept. 18th, to Fri., Sept. 22nd.—Forty-Second Annual Autumn Meeting at Bournemouth.

Institute of Road Transport Engineers

Tues., Aug. 22nd.—LONDON BRANCH: Visit to the works of Airscrew Company and Jicwood, Ltd., Weybridge, Surrey, 2.30 p.m.

Institution of Metallurgists

To-day to Sat., Sept. 30th.—Science Museum, South Kensington, London, S.W.7, Exhibition, "Metals in the Service of Mankind," weekdays, 9.30 a.m. to 6.30 p.m.; Sundays, 2.30 p.m. to 6.30 p.m.

Institution of Mining and Metallurgy

Tues., Sept. 19th, to Sat., Sept. 23rd.—Conference on Wire Ropes in Mines, at Ashorne Hill, Leamington Spa, Warwickshire.

Scientific Instrument Manufacturers' Association

Tues., Sept. 5th, to Fri., Sept. 8th.—Exhibition and Symposium at the Examination Hall, Queen Square London, W.C.1.

Personal and Business

GUEST, KEEN AND NETTLEFOLDS, Ltd., announces that Mr. Kenneth Swift Peacock has been appointed deputy chairman of the company.

MR. ERIC H. TYLER, general manager of Dowding and Doll, Ltd., Greycoat Street, London, S.W.1, has been elected a director of the company and will be particularly responsible for the extension of its British-made machine-tool programme.

MR. VERNON WALKER, A.M.I.E.E., who until recently was Deputy Resident Engineer and Technical Assistant with the Bury electricity undertaking, has been transferred to the North Western No. 2 Sub-Divisional Staff at Kearsley.

DOWDING AND DOLL, Ltd., Greycoat Street, London, S.W.1, has appointed Dufour Pere, Fils and Cie., 11, Rue Aspirant Dargent, Levallois-Perret (Seine), as sole agents for France and French Colonies for its British-made range of machine-tools.

THE ROYAL AGRICULTURAL SOCIETY announces that Mr. Michael Mason, of Eynsham Park, Witney, Oxon, has been appointed honorary director of the Royal Show, in succession to Sir Roland Burke, to whom he has acted as assistant during the past two years.

THE BURTONWOOD ENGINEERING COMPANY, Ltd., as a result of its experience at the Toronto Trade Fair, has appointed the S.K.F. Company as distributors for its universal oil seals throughout Canada. The Midland Foundry Company, Ltd., of Midland, Ontario, will handle Burtonwood garage and workshop equipment, together with "K.B." cylinder boring machines and certain types of "Beemee" compressors.

BRITISH THOMSON-HOUSTON COMPANY, Ltd., states that Mr. H. S. Holbrook, B.Sc., M.I.E.E., F.A.I.E.E., who relinquished the managership of the transformer engineering department of the company on August 1st, on being appointed consulting engineer on transformers, has been succeeded as manager of the department by Mr. K. W. McBain, M.I.Mech.E., M.I.E.E., M.A.I.E.E., latterly chief assistant to Mr. Holbrook.

THE BRITISH BROADCASTING CORPORATION announces that the following new appointments have been made in the Engineering Division. Mr. R. T. B. Wynn, C.B.E., M.A., M.I.E.E., deputy chief engineer, with responsibility under the chief engineer for the general control and direction of all engineering departments. Mr. H. L. Kirke, C.B.E., M.I.E.E., assistant chief engineer, with responsibility for the co-ordination and direction of the technical work of the research, planning and installation, designs and equipment departments. Mr. W. Proctor Wilson, C.B.E., B.Sc., M.I.E.E., succeeds Mr. Kirke as head of the research department and Mr. E. C. Drewe, M.I.E.E., becomes assistant head of the department.

Contracts

STEWARTS AND LLOYDS, Ltd., has been awarded dollar contracts to the value of over £2,000,000 by the American Oil and Natural Gas Companies, for the supply of many thousand tons of steel pipe-lines for shipment to the U.S.A. One of the largest orders was arranged through the Anglo-American Oil Company, on behalf of the Standard Oil Company, of New Jersey.

HENRY MEADOWS, Ltd., of Wolverhampton, has just secured in conjunction with the Minneapolis-Moline Company of Minnesota, U.S.A., a contract for the supply of tractors to the Greek Government. The diesel engines and ancillary units will be supplied by Henry Meadows, Ltd., and the American company will supply transmissions, wheels, gearboxes and all other parts. Assembly of the tractors is to be carried out in Greece under the supervision of technicians from Wolverhampton and Minnesota. This contract, is worth a total of £130,000, or 368,000 dollars.

Launches and Trial Trips

BERGESTRAND, motor tanker; built by the Netherlands Dock and Shipbuilding Company V.O.F., for Sig Bergesen and Co. A/S., Norway; length 151m, breadth 20·65m, depth 11·11m, deadweight 16,000 tons; Wilton-Fijenoord-Doxford oil engine, five cylinders, 5500 h.p. Launch, July 15th.

LONDON ENTERPRISE, motor tanker; built by Furness Shipbuilding Company, Ltd., for London and Overseas Freighters, Ltd.; length 496ft, breadth 67ft 6in, depth 36ft 5in, deadweight 16,250 tons; North Eastern Marine-Doxford oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5500 b.h.p. Launch, July 27th.

IXION, passenger and cargo liner; built by Harland and Wolff, Ltd., for Alfred Holt and Co.; length 485ft, breadth 69ft, depth 38ft 6in; one set of triple-expansion, double-reduction geared turbines, taking high pressure superheated steam from two Foster-Wheeler boilers, 14,000 s.h.p. Launch, July 28th.

WATERLAND, motor collier; built by Burntisland Shipbuilding Company, Ltd., for the Shipping and Coal Company, Ltd.; length 302ft, breadth 44ft 6in, depth 21ft 10in., deadweight 4000 tons; Kincaid-Harland and Wolff-Burmeister and Wain diesel engine, five cylinders, 500mm diameter by 900mm stroke. Launch, July 28th.

SILVERBEAM, motor tug; built by James Pollock Sons and Co., Ltd., for Silvertown Services, Ltd.; British Polar diesel engine, 605 b.h.p., 230 r.p.m. Launch, August 2nd.

FRIESLAND, motor collier; built by Burntisland Shipbuilding Company, Ltd., for Scheepvaart en Steenkolen Maatschappij N.V., Rotterdam; length 302ft, breadth 44ft 6in, depth 21ft 10in, deadweight 4050 tons; Kincaid-Burmeister and Wain-Harland and Wolff oil engine, five cylinders, 500mm diameter by 900mm stroke, 1500 b.h.p. Trial, August.

B.I.S.R.A. APPOINTMENTS.—The British Iron and Steel Research Association announces that Dr. C. Sykes, director of research of the Brown-Firth research laboratories, has retired from the chairmanship of the divisional panel of its metallurgy division and has been succeeded by Mr. W. Barr, chief metallurgist of Colvilles, Ltd. Mr. G. H. Johnson, managing director of the Kettering Iron and Coal Company, Ltd., has retired from the chairmanship of the divisional panel of the B.I.S.R.A. Iron Making Division, and Mr. W. C. Bell, joint director of research of Stewarts and Lloyds, Ltd., has accepted the chairmanship. Mr. Johnson has agreed to act as deputy chairman for the period of a year. It is stated that a three-year period is usual for members of B.I.S.R.A.'s committees, one-third retiring each year and becoming ineligible for re-election for twelve months. In this way the "load is spread," and B.I.S.R.A.'s wide basis of contact throughout the industry is maintained.